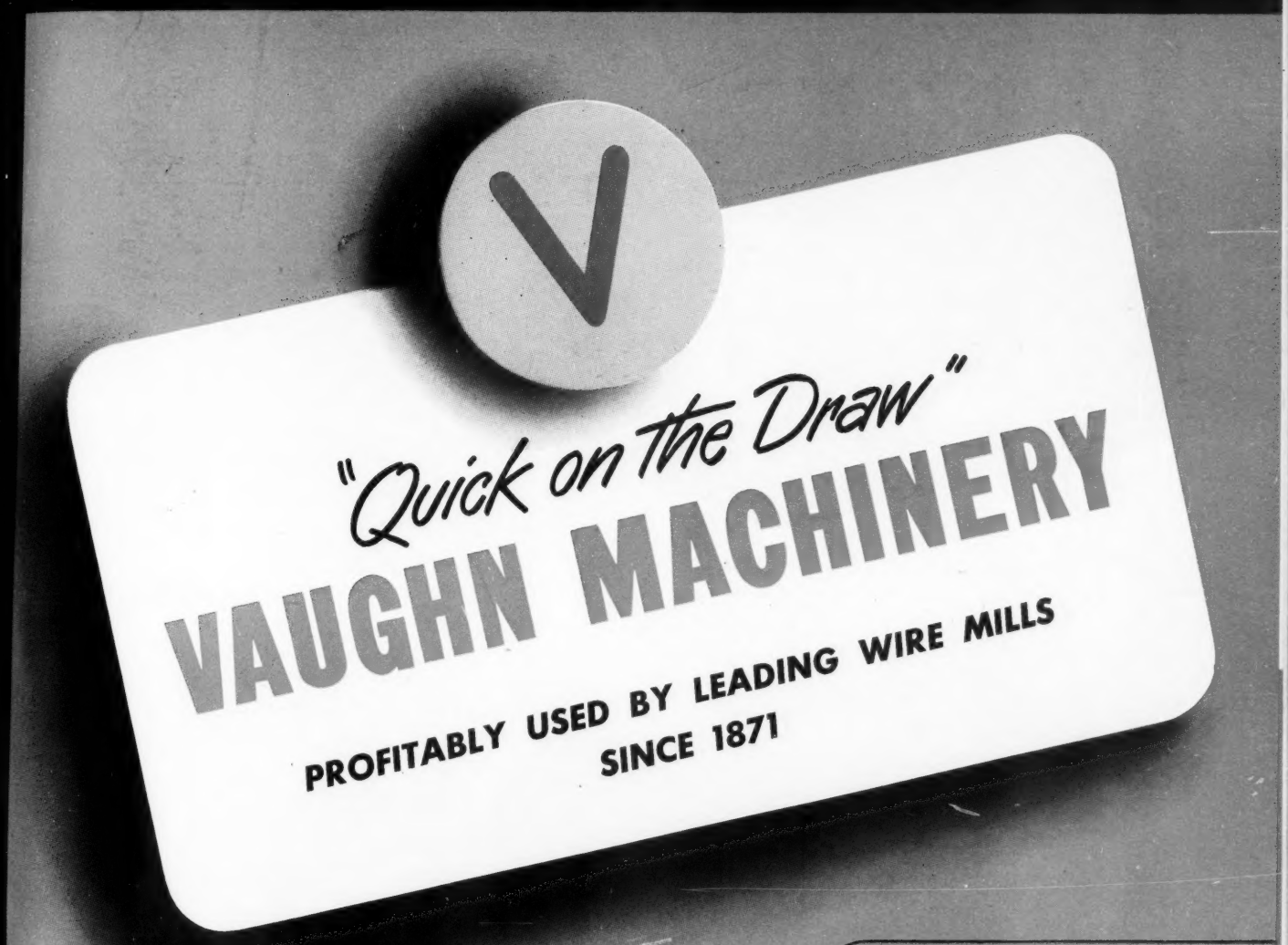
OCTOBER, 1949

WIRE AND WIRE PRODUCTS



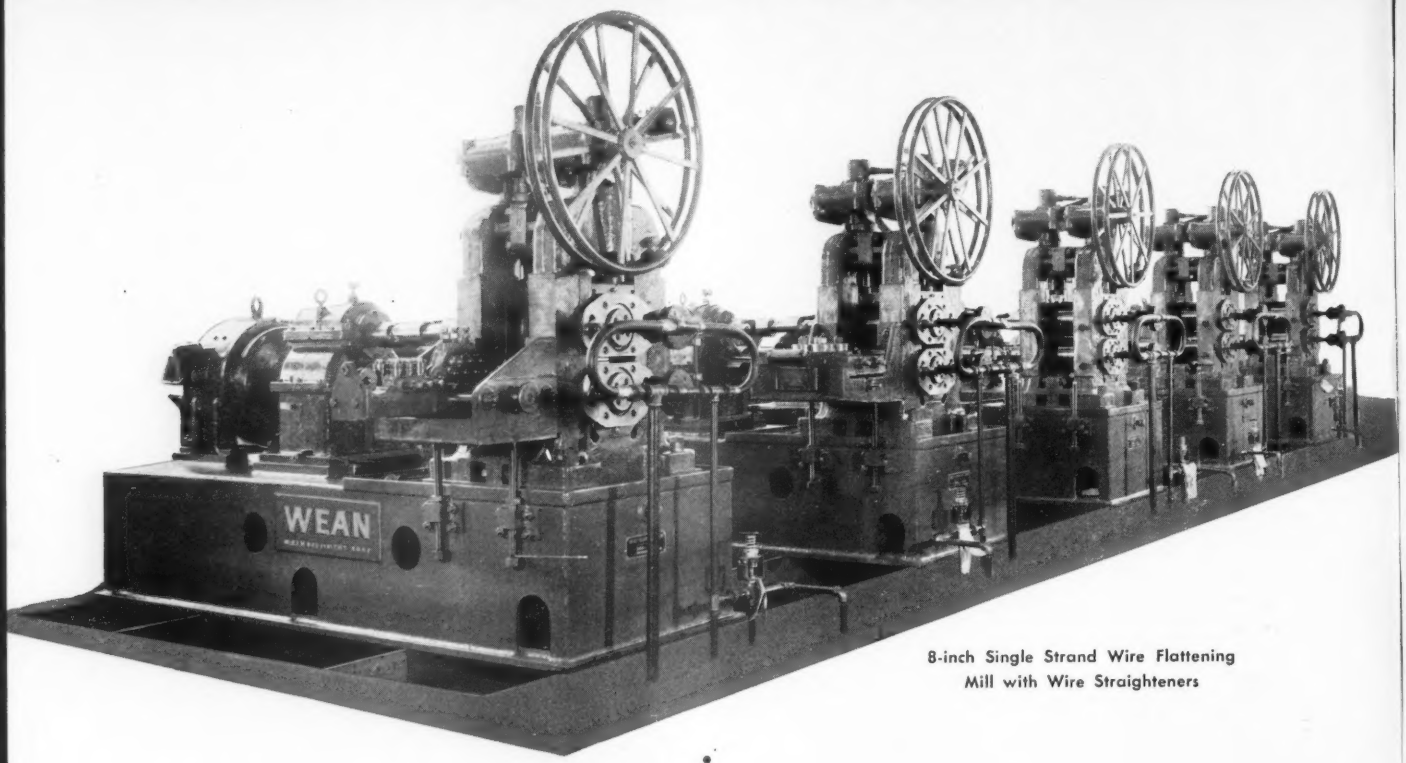
SEE PAGES 872, A, B, C, D

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire...Ferrous, Non-Ferrous Materials or their Alloys.

OFFICIAL PUBLICATION OF THE WIRE ASSOCIATION

Wean



8-inch Single Strand Wire Flattening Mill with Wire Straighteners

THE WEAN EQUIPMENT CORPORATION are recognized as specialists in high-efficiency narrow strip, wire mill and straightening equipment.

COLD ROLLING MACHINERY

For 36" Wide Material and Narrower

MILLS - REELS - SLITTERS - LEVELERS
COILERS - EDGERS - SCALE BREAKERS - SHEARS
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WIRE MILL EQUIPMENT

PATENTING, GALVANIZING AND TINNING TAKE-UP FRAMES
WIRE FLATTENING MILLS - SPOOLERS - NAIL GALVANIZING AND BLUEING EQUIPMENT - FIELD FENCE AND BARBED WIRE MACHINES

TUBE BAR AND SHAPE STRAIGHTENING MACHINERY

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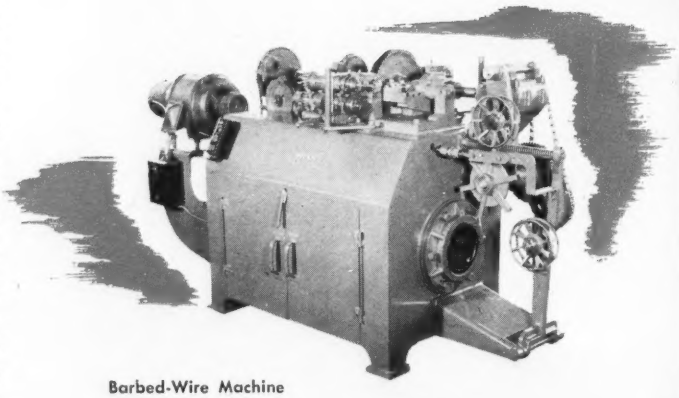
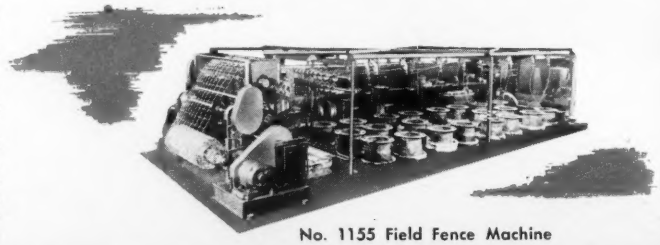
22800 LAKELAND BLVD. • CLEVELAND, OHIO



Barbed-Wire Machine

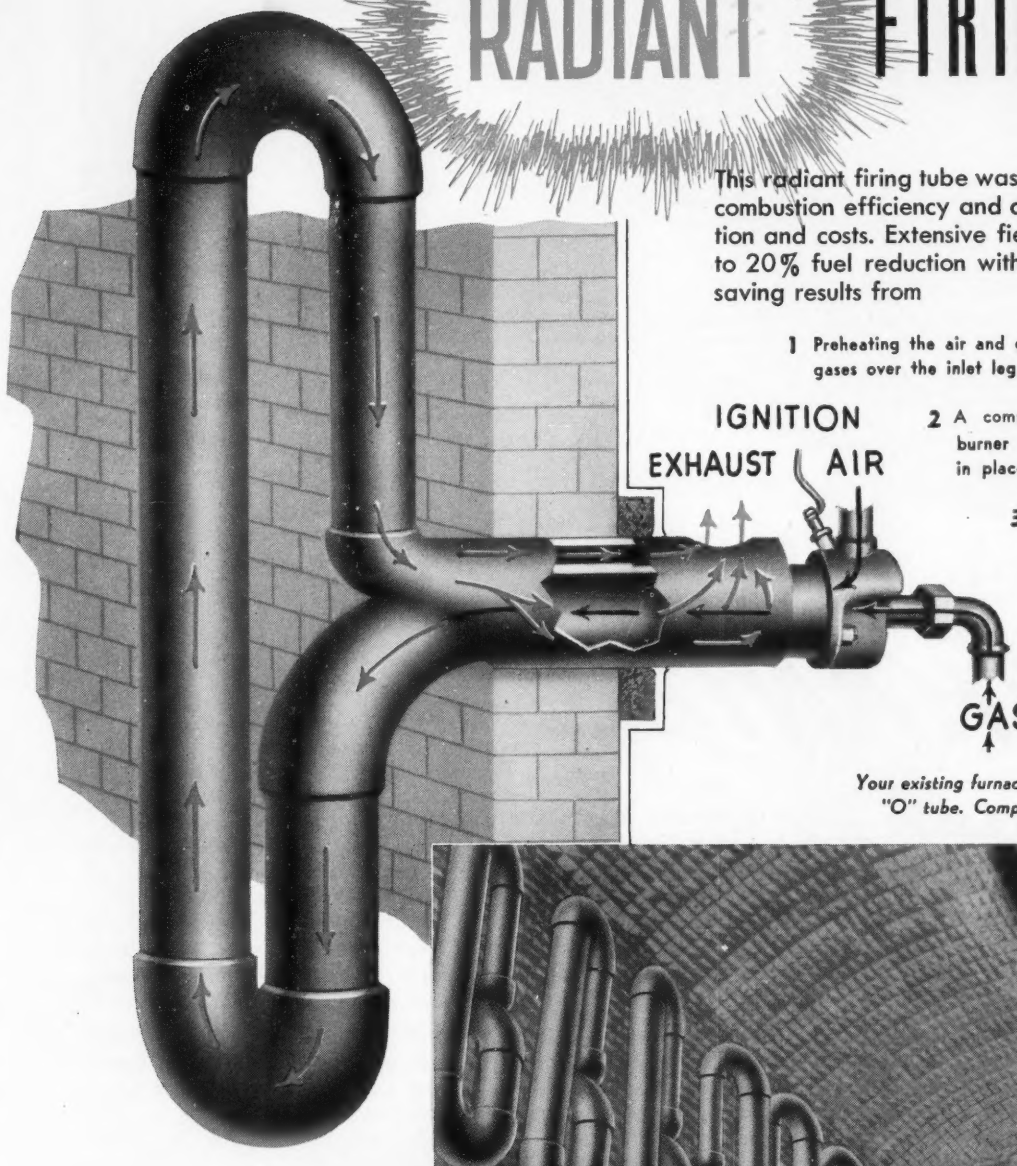


No. 1155 Field Fence Machine

Wean *Equipment Corporation*

CLEVELAND / OHIO

Lee Wilson ANNOUNCES THE "O" TYPE RADIANT FIRING TUBE



This radiant firing tube was developed to increase combustion efficiency and decrease fuel consumption and costs. Extensive field tests indicate a 15 to 20% fuel reduction with longer tube life. This saving results from

1 Preheating the air and gas by passing the exhaust gases over the inlet leg of the tube.

2 A completely tight furnace at the burner mounting—tubes are welded in place.

3 The use of the Lee Wilson dual pressure burner, with primary and secondary air adjustment, which can increase heat release at bottom of tube to apply radiant energy most effectively.

Your existing furnaces can be converted to use the "O" tube. Complete information on request.

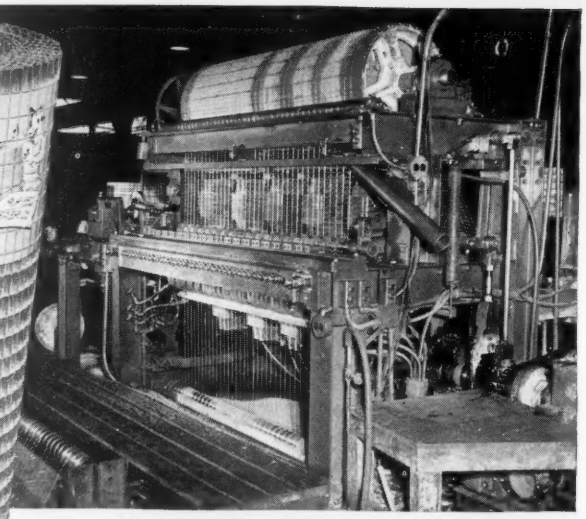
This picture shows interior of a furnace fitted with 36 "O" tubes. This unit must be completely gas tight for carbon restoration application.

Lee Wilson ENGINEERING Co., Inc.

20005 WEST LAKE ROAD • CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES



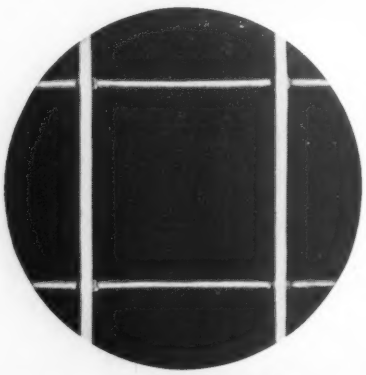
One of the welding machines engineered by Forbes Steel Corporation, Canonsburg, Pa. Bethanized wire is fabricated into strong, uniform fabrics by electronically-controlled welding.

Welded Fabric made of BETHANIZED WIRE

for smooth, bright finish

. . . extra corrosion-resistance

. . . sound, clean welds



This close-up view of 1 x 1-in. mesh shows the neat welding job. The excellent metal-to-metal bond between the bethanized wires produces a strong, corrosion-resisting joint that is clean and free from discoloration.

Forbes Galvanized Wire Fabric, made by Forbes Steel Corporation, Canonsburg, Pa., for a long list of uses from machinery guards to poultry-coop flooring and corn-cribbing, is another of the many products that owe much of their popularity to bethanized wire.

Bethanized wire's uniform coating of bright, pure zinc gives the fabric sparkling sales appeal and assures long protection against corrosion. And manufacture is aided by the ease with which bethanized wire is welded. Welds are so sound and clean that the manufacturer has found that fabric life at the welds exceeds even that of the line wires.

New users of bethanized wire are always amazed by our ability to make its zinc coating so perfectly bonded all the way around the steel wire, and so uniform that there's no foothold for corrosion. Equally important in many applications is the exceptional coating ductility made possible by the 99.9-pct-pure zinc which is deposited atom by atom in our unique electrolytic process. Twist bethanized wire, wrap it, or form it, and you won't see any zinc flaking or peeling off.

Whether you need hard- or soft-temper wire, standard or heavy zinc coatings, we'd like to show you how bethanized wire can add sales appeal to your products.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation.

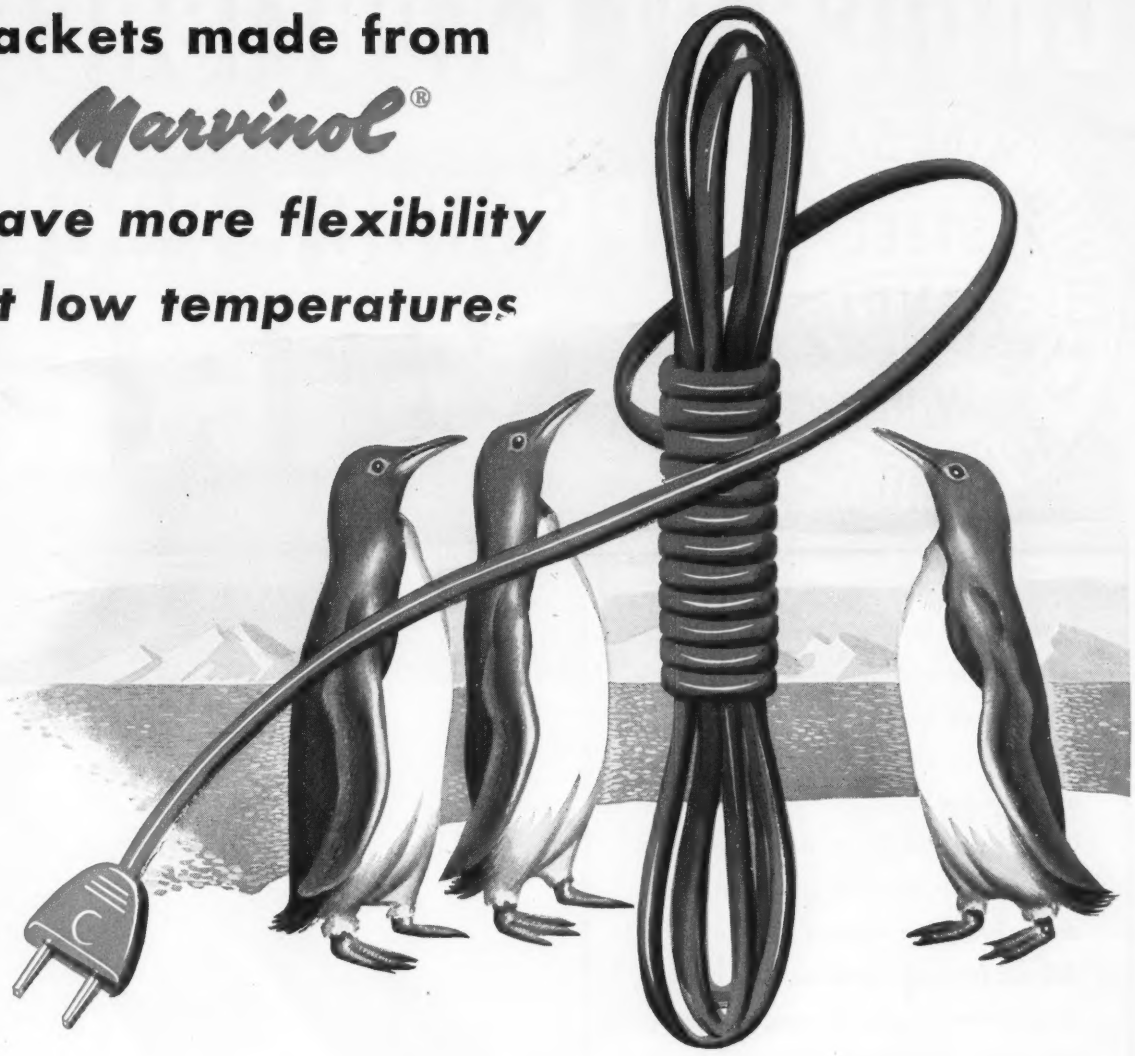
Export Distributor: Bethlehem Steel Export Corp.

★ BETHLEHEM STEEL ★

WIRE & WIRE PRODUCTS, Vol. 24, No. 10, October, 1949. Publication Office, at One Sherman Ave., Jersey City 7, N. J. Executive Office, 300 Main Street, Stamford, Conn. Published monthly by the Quinn-Brown Publishing Corp., Richard E. Brown, President; R. S. Spengel, Secy. and Treas. Subscription price: U. S. $5.00; Canada, $5.00 per year; 50 cents per copy; Foreign, $7.50 per year. Entered as second class matter, January 10, 1949, at the Post Office, Jersey City, N. J., under Act of March 3, 1879.

Jackets made from Marvinol®

have more flexibility at low temperatures



. . . and in coats and jackets for wire, flexibility at low temperatures is important. But Marvinol's characteristics are just as outstanding under heat . . . there's less deformation with Marvinol VR-10.

Marvinol-based wire coats and jackets are drier, tougher . . . with better resistance to "cut-through," abrasion and the destructive forces of light, aging, oils and acids.

Marvinol extrudes faster. It saves time in compounding and mixing because of shorter pre-mix, open-mill and Banbury cycles. If you do not do your own compounding, let us show you how you can save money by performing this operation right in your own plant.

The Glenn L. Martin Company makes and sells Marvinol vinyl resin as a raw material to processors. It compounds and fabricates only in modern customer service laboratories for your benefit. So if you extrude insulation or jackets over wire and want information . . . or if you use insulated wire and want the name of someone now using Marvinol vinyl resin, write to Chemicals Division, Dept. W-10, THE GLENN L. MARTIN COMPANY, BALTIMORE 3, MARYLAND.

MANUFACTURERS OF: Dependable Martin 2-0-2 airliners • Advanced military aircraft • Revolutionary rockets and missiles • Electronic fire control systems • Versatile Marvinol resins (Martin Chemicals Division) • **DEVELOPERS OF:** Mareng fuel tanks (licensed to U.S. Rubber Co.) • Stratovision aerial re-broadcasting (in conjunction with Westinghouse Electric Corp.) • Honeycomb construction material (licensed to U.S. Plywood Corp.) • New type hydraulic automotive and aircraft brake • Permanent fabric flameproofing • **LEADERS IN RESEARCH** to guard the peace, build better living in far-reaching fields.

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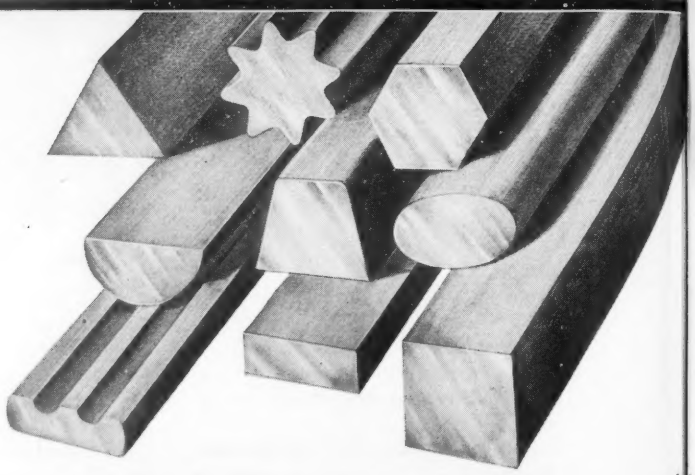
Hundreds of leading manufacturers demonstrate a strong "repeat" preference for Continental wire. Their own products have proved the worth of this wire. Their own experience has convinced them that Continental has the wire that wins customer friends. Whether your need is for a rust-resistant wire that can stand up under difficult forming operations . . . or for a shaped wire to provide smarter-looking, longer-lasting trim—whatever the nature of your own product—Continental wire can help you build a better, more profitable product. Continental wire is uniform in temper, uniform in coating. It is made to fit specific manufacturing and fabricating requirements. Write Continental at Kokomo. Tell us about your wire needs.



CONTINENTAL WIRE

Shaped to Fit Your Special Needs

Continental special shaped wire has product-proved "sales appeal." It is helping boost the market appeal of many products. The things you make may have one or more parts which can be "shape-engineered" from wire to do a better job . . . with added profit for you. Continental's handy booklet of helpful wire information will be sent you free on request.

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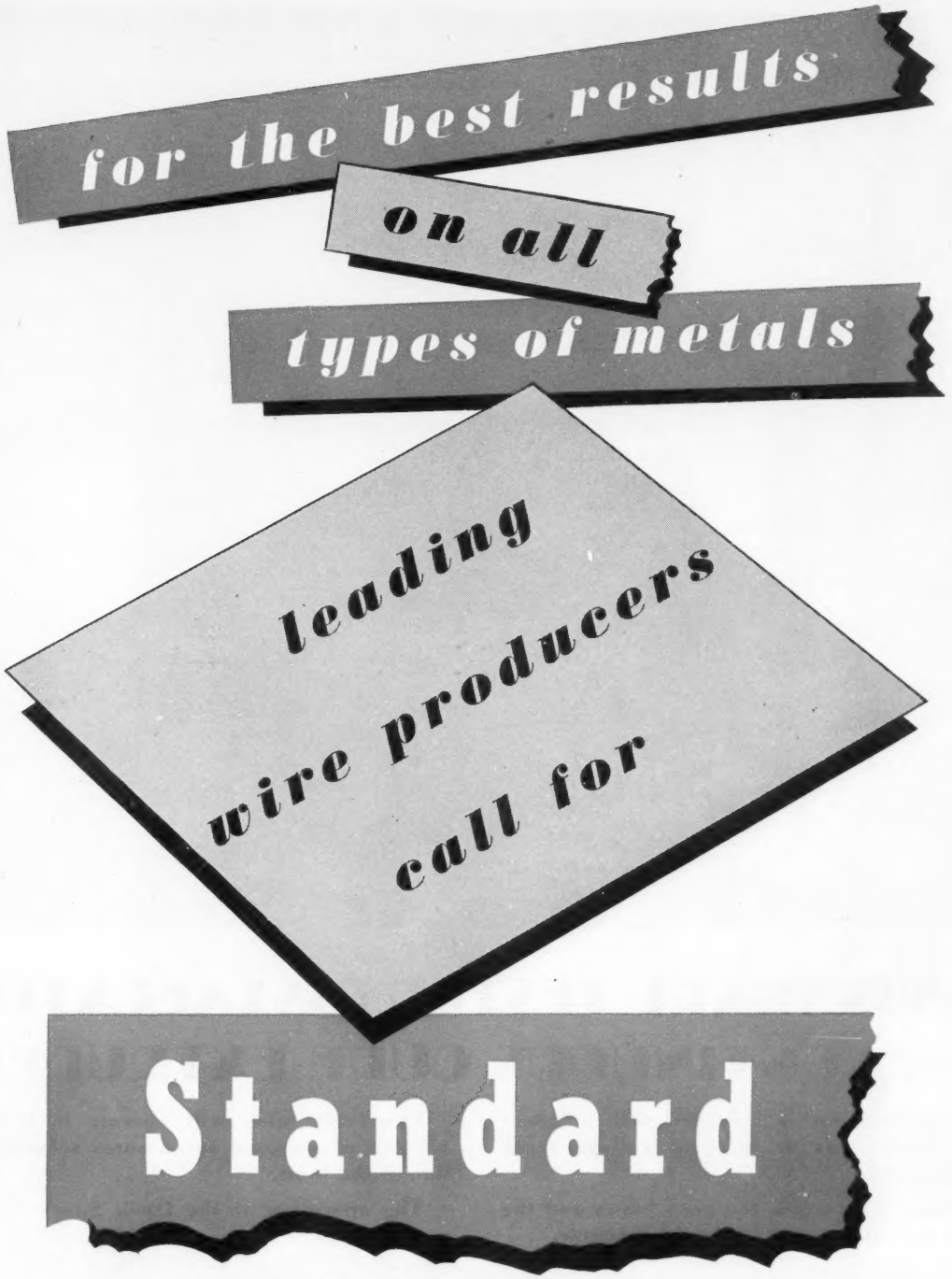
CONTINENTAL STEEL CORPORATION

GENERAL OFFICES • KOKOMO, INDIANA

PRODUCERS OF *Manufacturer's Wire* in many sizes, shapes, tempers and finishes, including Galvanized, KOKOTE, Flame-Sealed, Coppered, Tinned, Annealed, Liquor Finished, Bright, Lead Coated, and special wire. ALSO, Coated and Uncoated Steel Sheets, Nails, Continental Chain Link Fence, and other products.



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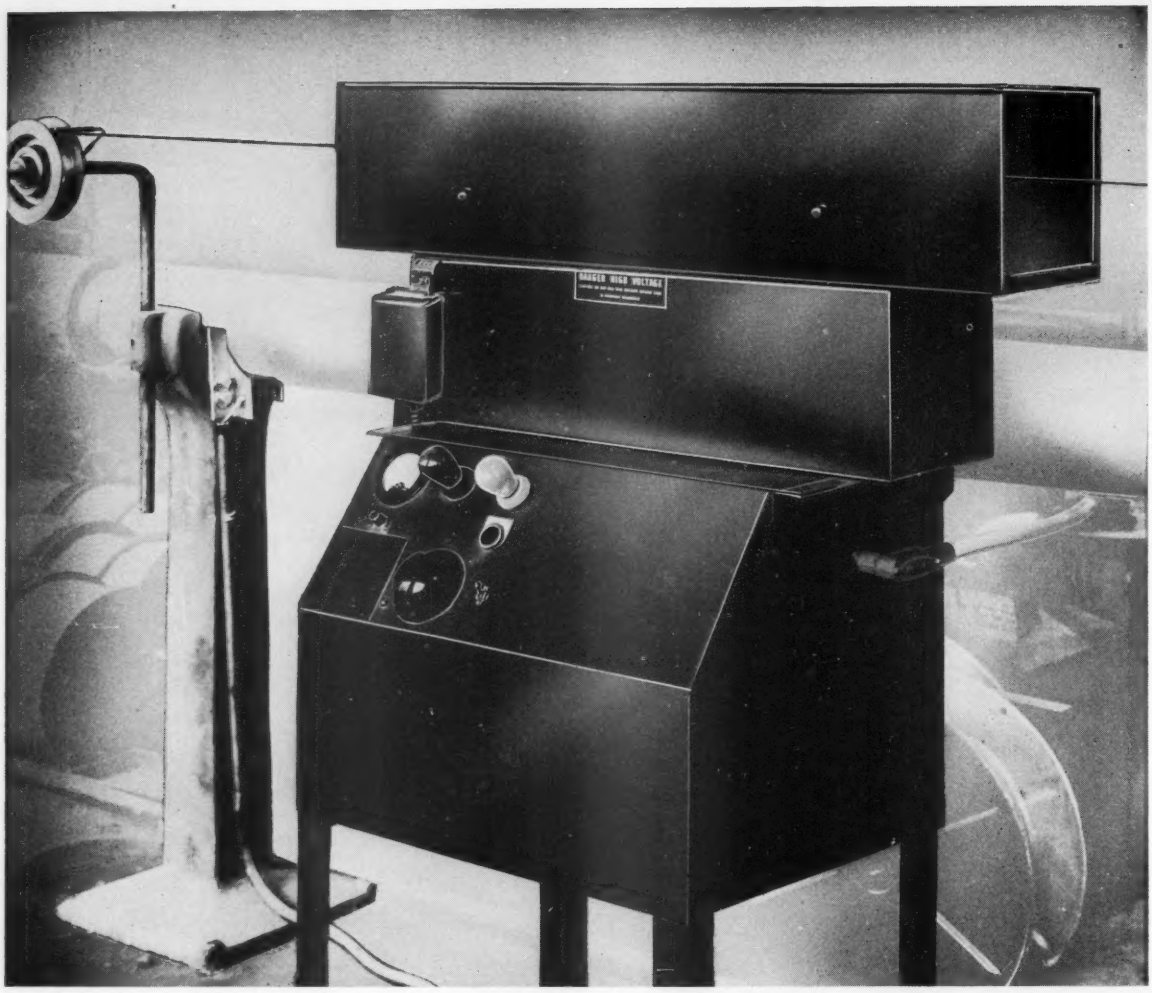


DAVIS SPARK TESTER INSTALLATION ON CONTINUOUS CURE EXTRUDER

The spark tester is equipped with a transformer which has a range of voltage from 3,000 to 16,000.

When a fault occurs the horn blows and the fault is registered on the resetable counter.

The fault relay will operate in less than 1/180th of a second and assures accurate location of the fault.

The operation of the Davis Spark Tester is not affected by wet wire.

Meets Underwriter's Laboratories' specifications for spark testing!

Write us today for detailed information!

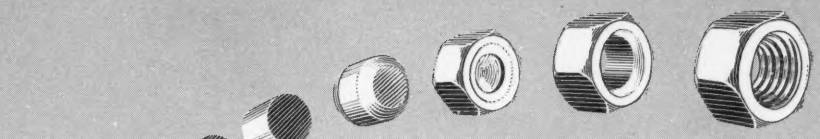
DAVIS EQUIPMENT

THE R. L. DAVIS ELECTRIC CO., INC. • WALLINGFORD, CONN.

SPARK TESTERS • SPOOLERS • TAKE-UPS • CAPSTANS

Scrapless Nut Wire

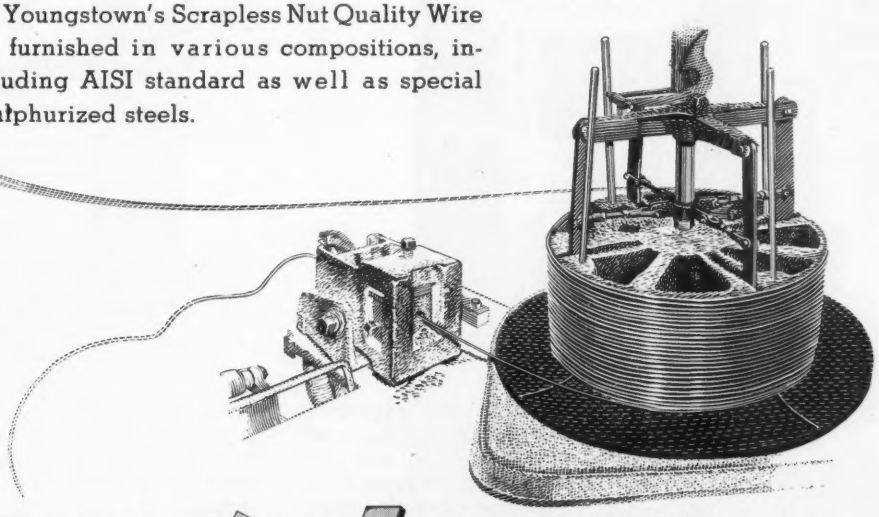
custom built to meet customers' requirements



SCRAPLESS Nut Quality Wire is not an ordinary steel for common applications. It is a custom built product designed to meet customers' specific requirements for cold heading, cold punching, cold expanding and threading, in the production of a variety of nut shapes on continuous heading machines.

Every step of its manufacture is carefully controlled--from the melting furnaces to the final drawing operation on the wire machines. Each coil of wire is subjected to close inspection and rigid tests with modern electrical testing apparatus.

Youngstown's Scrapless Nut Quality Wire is furnished in various compositions, including AISI standard as well as special sulphurized steels.



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THE YOUNGSTOWN SHEET AND TUBE COMPANY

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ENAMELED ALUMINUM	COTTON COVERED	SPECIALS TO ORDER

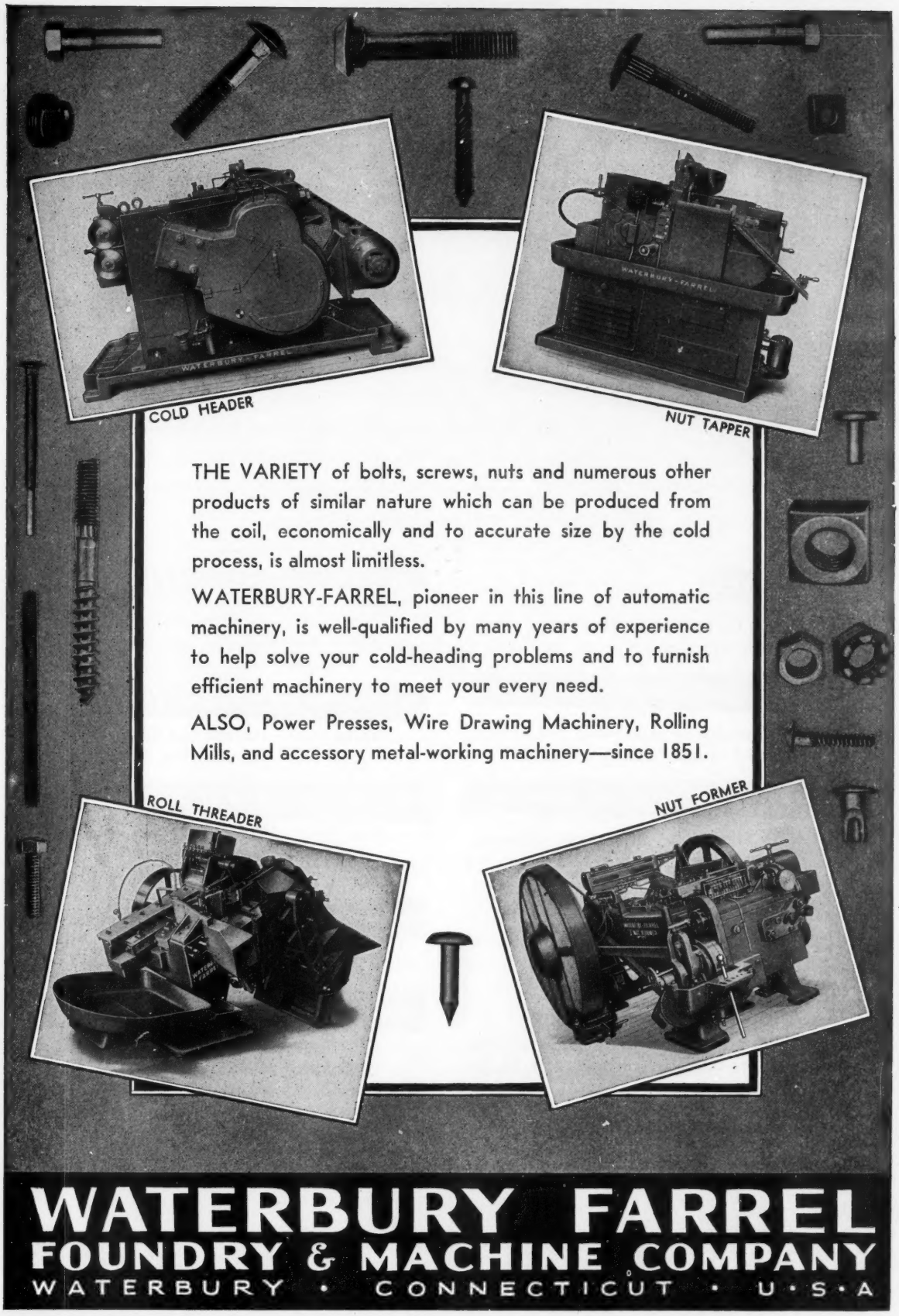
There's more to present day engineering and design problems than shortages of materials, priorities, etc. There is also the question of whether specifications have been rigidly adhered to. Wire, for example, must meet such requirements as specific electrical properties, flexibility, tensile strength, laying speed, uniformity, etc.

Whether it's a buyer's or seller's market, WINCO magnet wire products are drawn to exact specifications. Uniformity of product is guaranteed by mercury process tests and careful supervision guards against variations in consistency, structure or electrical values.

If you have a wire problem, our complete facilities are at your disposal. Send blueprints or specifications for recommendations, without obligation. Samples sent on request; write today.

WINSTED DIVISION

WINSTED HUDSON WIRE COMPANY CONNECTICUT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NUT TAPPER
THE VARIETY of bolts, screws, nuts and numerous other products of similar nature which can be produced from the coil, economically and to accurate size by the cold process, is almost limitless.
WATERBURY-FARREL, pioneer in this line of automatic machinery, is well-qualified by many years of experience to help solve your cold-heading problems and to furnish efficient machinery to meet your every need.
ALSO, Power Presses, Wire Drawing Machinery, Rolling Mills, and accessory metal-working machinery—since 1851.
ROLL THREADER
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MACHINERY FOR HIGH SPEED PRODUCTION OF CABLES, STRANDS AND INSULATION

BUTT Wire Working Equipment is backed by many years of experience in the designing and building of machinery for the Wire Industry. Fast and dependable, BUTT Machines are ideal for maintaining product quality, boosting output, reducing maintenance, and building profits.

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Types for all purposes in sizes up to 64-carrier. (Circulars Nos. 28, 90, and 91)

CABLE CLOSING MACHINES

Various sizes up to 60" diam. reel for 3, 4, 7, and 8 strands. (Circular No. 80)

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Five sizes, from 3 to 6 spools. (Circular No. 71)

CAPSTAN TAKE-UP UNITS

Machines for any number and size of reels. (Circular No. 79)

MOTORIZED TAKE-UPS

Machines can be made for any number and size of reels. (Circulars Nos. 78, 79, and 92)

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Two sizes — for bunching wires up to # 14 B. & S. gage and strands up to # 8 B. & S. gage. (Circular No. 63)

RIGID TYPE STRANDERS

Three sizes — 100, 300, and 500 lb. spools, 6 to 30 reels. (Circular No. 70)

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Sizes for 100, 250, and 500 lb. spools, for combinations of stranded wire from 7 to 91 ends. (Circular No. 84)

HIGH SPEED STRANDERS

Capacities from 7 to 41 reels. (Circular No. 73)

TAPING MACHINES

Horizontal, Eccentric, and Concentric types, single or multiple heads. (Circulars Nos. 77, 81, and 83)

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Even if display racks aren't your line, they belong in your thinking. Better display racks stay bright . . . catch customer's eyes. Better display racks are made of Alcoa Aluminum Wire because aluminum keeps its lustrous finish. This customer-catching advantage can make your products more salable, too.

Alcoa Wire forms easily on your present equipment. Paint it or plate it if you desire . . . aluminum holds the finish. Pound for pound, it goes three times further than heavy metals. Let your local Alcoa salesman give you all the facts and free books like "Alcoa Aluminum and Its Alloys" plus "Finishes for Alcoa Aluminum". Or write ALUMINUM COMPANY OF AMERICA, 1828L Gulf Bldg., Pittsburgh 19, Pa.

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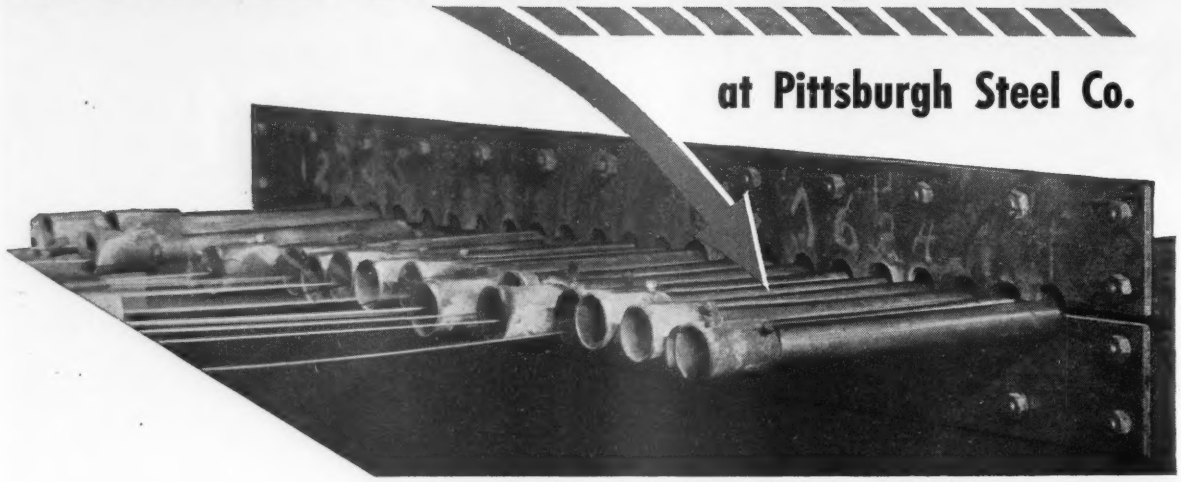
INCONEL here keeps annealing costs down

at Pittsburgh Steel Co.



In bright annealing furnaces of the Pittsburgh Steel Company, stainless steel wire moves continuously through a hydrogen-nitrogen atmosphere in tubes heated to 2000° F.

Pittsburgh chose INCONEL* as the metal for their furnace tubes . . . and subsequent performance records have proved the wisdom of their choice.

High temperature, corrosion-resistant, INCONEL has set endurance records in many of the nation's busiest heat-treating furnaces. For example . . . in the bright-annealing of Nickel and Monel* wire, at 1950° F., *two years' life* is reported for seamless extruded INCONEL tubing, where wire-drawing lubricants are sulphur and lead free.

In other heat-treating applications, INCONEL furnace fixtures have outlasted other quality metals with corresponding savings in maintenance and replacement costs.

If you would like to know how other plants have made considerable savings through the use of INCONEL . . . and why leading fabricators regard it as the *standard* metal for heat-treating fixtures, write for your copy of *"Keep Operating Costs Down When Temperatures Go Up."*

INCONEL SEAMLESS TUBING NOW AVAILABLE IN LARGE DIAMETERS

Seamless extruded Inconel tubing is now being produced in outside diameters of 2½" to 8½", with wall thicknesses from ¼" to ⅜". For quotations, check with your nearest INCO distributor.

THE INTERNATIONAL NICKEL COMPANY, INC.
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EMBLEM OF SERVICE
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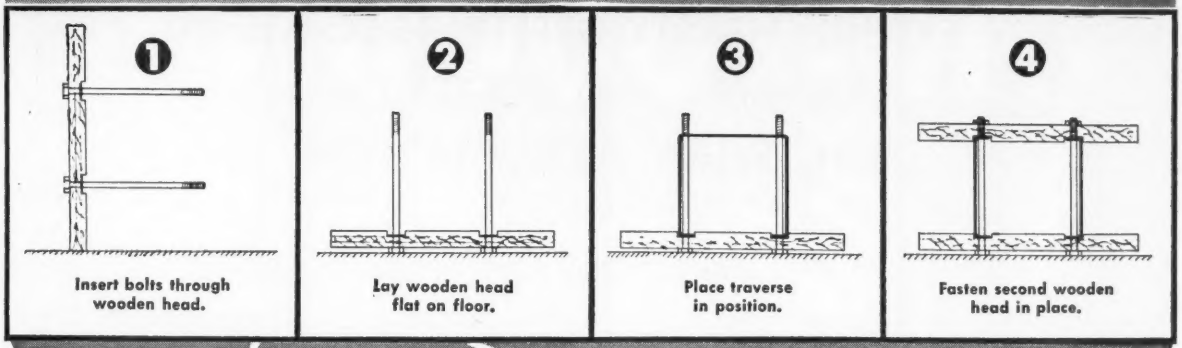
INCONEL*...for long life at high temperatures

Save Time • Labor • Space • Money through this simple 4-Step Assembly of NILES Flanged Steel Traverses



Niles Flanged Steel Traverses save time... because they require only four simple steps in reel assembly. They save labor . . . no special tools are necessary. They may be stacked and stored in a minimum amount of room... thus saving space. And they save money by providing long service life. Actual experience records show that Niles Flanged Steel Traverses have given as much as sixteen year's service–without refinishing or major maintenance. In many cases their use has doubled the number of trips per reel before cut downs or scrapping of wooden heads.

Niles "Reinforced Type" Steel Traverses have *extra strength* where it is needed most–at bolt holes and base of flange. Reinforcing makes possible the use of lighter gauge steel, saving up to 20% in weight while increasing overall length.

Sizes of Niles Flanged Steel Traverses range up to 56" diameter and 48" traverse. Finishes include plain, painted and hot dip galvanized. Width of flange and number of bolt and drain holes can be furnished to your specifications. Write today for prices.

NILES STEEL PRODUCTS DIVISION
REPUBLIC STEEL CORPORATION
NILES, OHIO

REPUBLIC STEEL

NILES
FLANGED STEEL TRAVERSES

MICROMETER PRECISION MICRO WELD TRADE MARK REG. U. S. PAT. OFF.

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EXTENDS HEARTY GREETINGS TO ALL
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MICRO-WELD BUTT WELDERS ARE MANUFACTURED IN DIFFERENT MODELS TO BUTT WELD HIGH AND LOW CARBON STEEL AND STEEL ALLOYS IN SIZES FROM .004" TO 1¼" DIAMETER, AND NON-FERROUS WIRE AND RODS RANGING IN SIZE FROM .004" TO ⅞" DIAMETER

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DISCUSS YOUR WIRE WELDING PROBLEMS WITH OUR MR. G. L. MAY, WHO WILL BE IN ATTENDANCE DURING THE CONVENTION

MICRO PRODUCTS COMPANY

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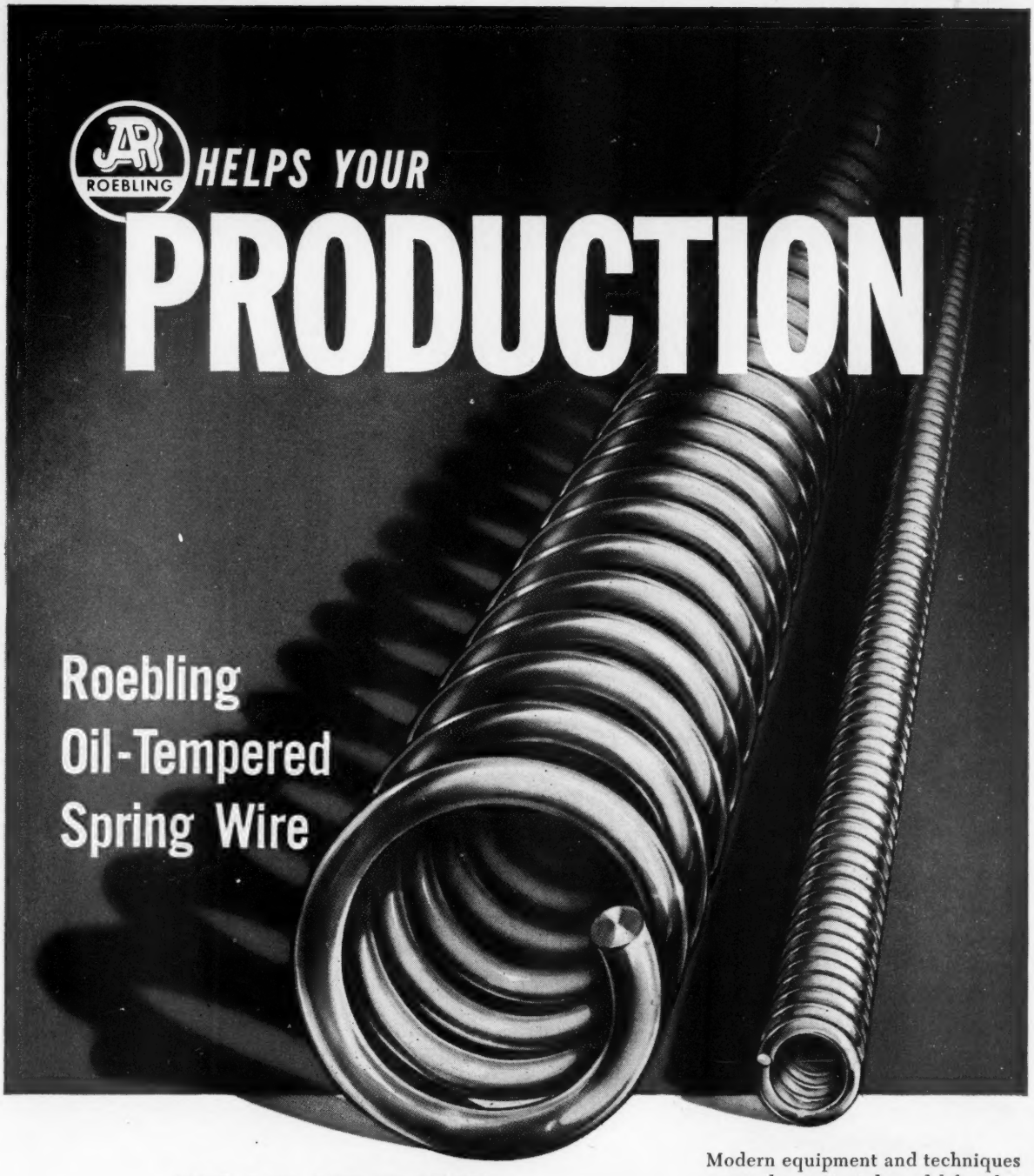
Cable address: MICROWELD, CHICAGO Telephone STATE 2-7468



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YOU'LL CUT DOWN machine stoppages and minimize rejects with Roebling Oil-Tempered Spring Wire. This wire is a *quality* product. Every inch is identical in gauge and finish... uniformly up to snuff in mechanical and metallurgical properties.

Roebling Oil-Tempered Spring Wire is available now. Roebling has developed one of the largest wire mills in the country for making specialty wires. From making the steel to the finished product, every manufacturing phase is performed in Roebling's own plants. Modern equipment and techniques assure the constant dependability that has earned Roebling a century of confidence.

Your Roebling Field Man will gladly help you choose the best wire—round, flat or shaped—for utmost efficiency and economy in your products. John A. Roebling's Sons Company, Trenton 2, New Jersey.

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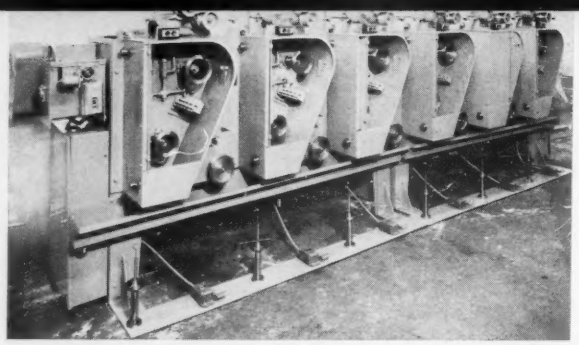
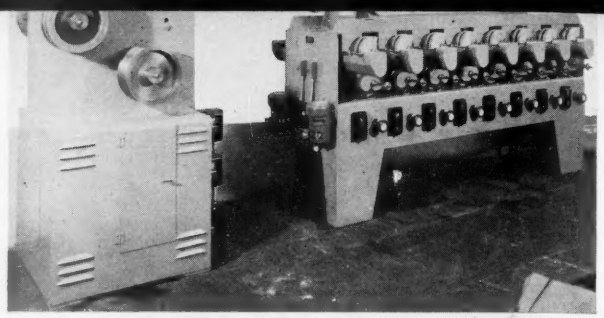
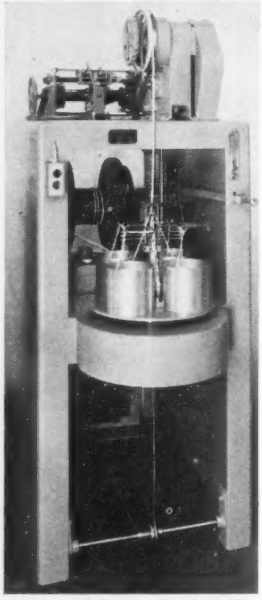


No. 934—Six Unit Fine Wire Drawing Machine



No. 966—Torque Motor Take-Up with Capstan



No. 974—Asbestos Serving Machine for Heater Cord

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PHILADELPHIA PENNSYLVANIA U.S.A.

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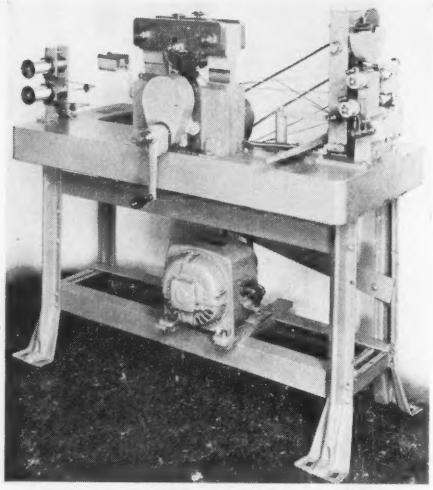
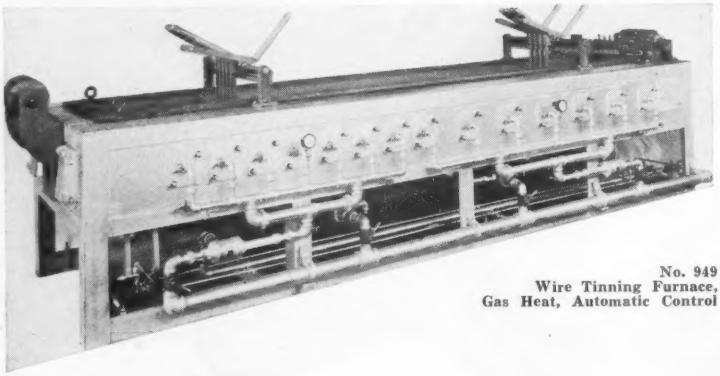
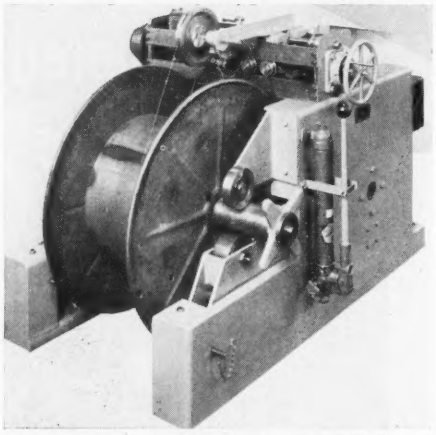


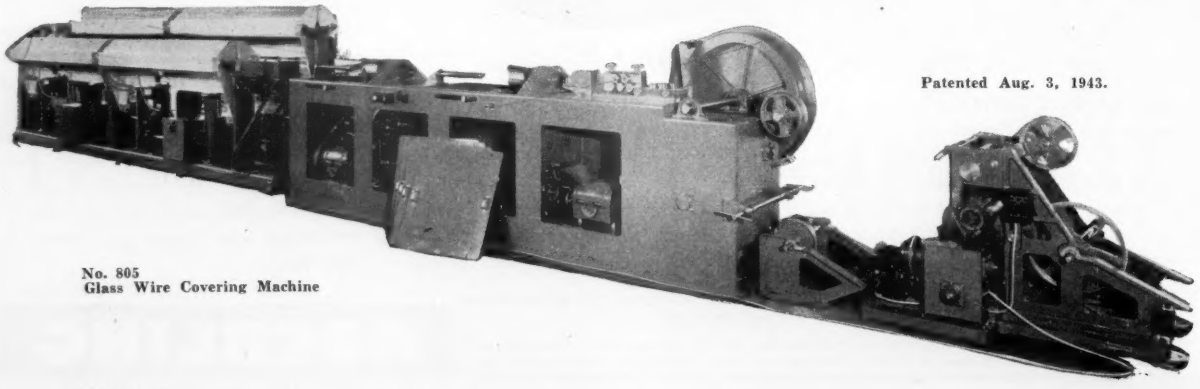
No. 926—Tinsel Rolling Mill



No. 949
Wire Tinning Furnace,
Gas Heat, Automatic Control

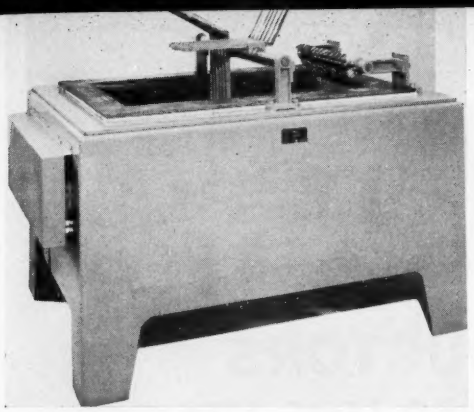


No. 976—Take-Up Reel-Stand, Hydraulic Lift

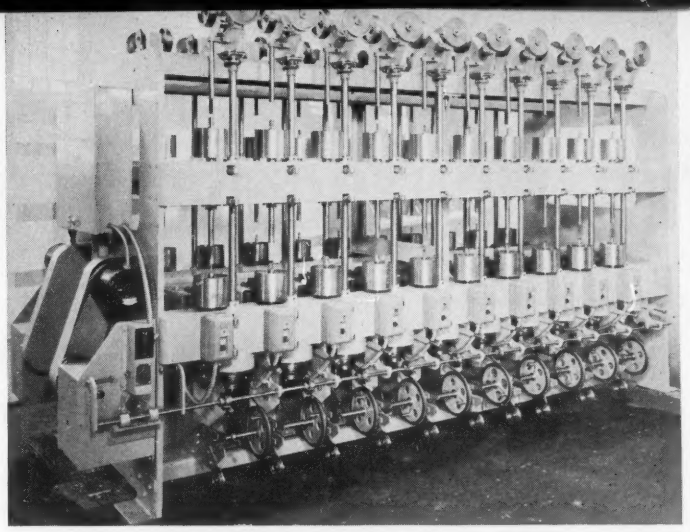


Patented Aug. 3, 1943.

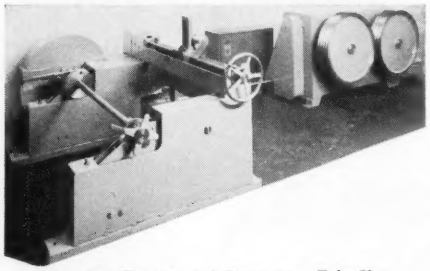
No. 805
Glass Wire Covering Machine



No. 953—Wire Tinning Furnace, Electric Heat, Automatic Control



No. 957—Model 1-D-20 MBB Insulation Winding Machine



No. 981—Capstan and Drum type Take-Up

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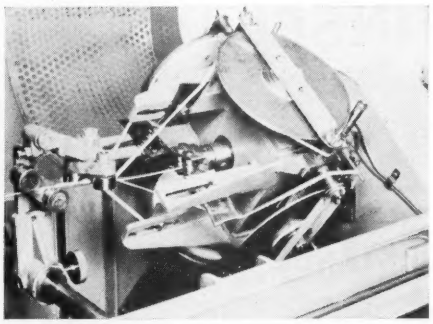
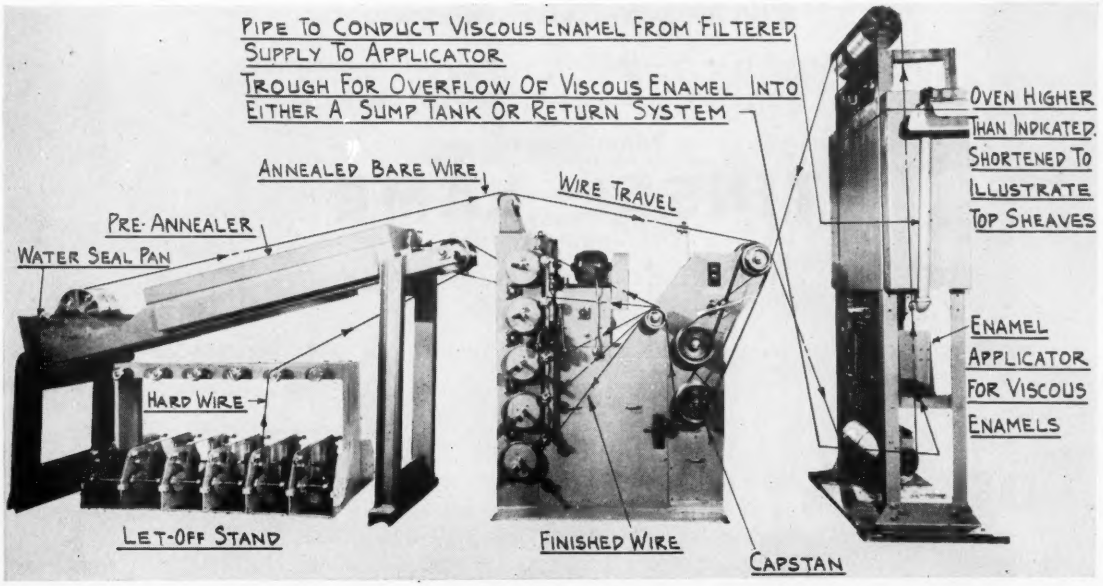
COMPLETE LINE OF WIRE DRAWING, ENAMELING, TINNING, WINDING, INSULATING, TAPING, GLASS-COVERING, PANNING, AND ALLIED MACHINERY.



No. 889—Quadruple Taping Head

No. 971—Enameling Machine for Die Application of Viscous Enamels


PIPE TO CONDUCT VISCOUS ENAMEL FROM FILTERED SUPPLY TO APPLICATOR
TROUGH FOR OVERFLOW OF VISCOUS ENAMEL INTO EITHER A SUMP TANK OR RETURN SYSTEM
OVEN HIGHER THAN INDICATED. SHORTENED TO ILLUSTRATE TOP SHEAVES
ANNEALED BARE WIRE
WIRE TRAVEL
PRE-ANNEALER
WATER SEAL PAN
ENAMEL APPLICATOR FOR VISCOUS ENAMELS
HARD WIRE
LET-OFF STAND
FINISHED WIRE
CAPSTAN

THE MONTGOMERY COMPANY—EST. 1871

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BARE TINSEL CONDUCTORS

TO GIVE EXTREME FLEXIBILITY AND LONG LIFE

in

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(2) Telephone Switchboard Cords
(3) Head Set Cords for Radio-Television, etc.
(4) Electric Razor Cords
(5) Hearing Aid Cords
(6) Radio Loudspeaker Voice Coil Leads
(7) Leadin Wires for Electrically Heated Blankets, Clothing, etc.
(8) To meet National Electric Code Standard for Flexible Tinsel Cords.

Wound on reels ready for insulating with plastic, rubber, etc.

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Write for samples and engineering data.

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Silver Plated . . . False Gold Coated

Assorted Sizes

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Packaged for weaving . . . knitting, etc. of Dress — Slipper — Millinery Fabrics, Braids & Trimmings.

To meet your requirements

If it can be wound on a reel, spool or bobbin, Apco Mossberg can fill your needs.

For over 50 years we have specialized in the manufacture of spools and reels of all kinds. Our plant is fully equipped with modern machinery to manufacture almost any conceivable kind, type and size of steel spool, reel and bobbin, in large quantities or small.

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An interesting brochure, recently published, gives considerable useful information, illustrating and describing a few score of the various Apco Mossberg spools and reels that find the largest application in industry today. Write for a copy.

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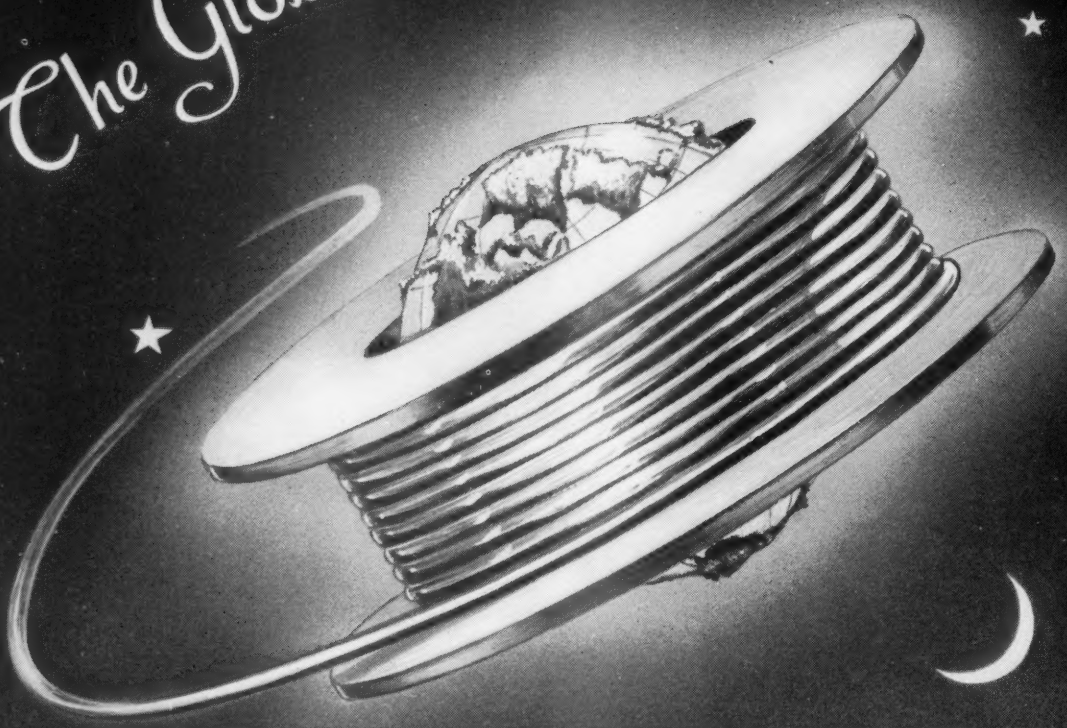

many times with lead encased cables *produced on Robertson Equipment*

Someone once said: *"The proof is in the pudding."* And when we adapt it to read, "The proof is in the cable," we mean lead encased cable as produced on Robertson Lead Encasing Presses.

Robertson High Pressure Hydraulic Equipment is designed and manufactured by skilled craftsmen ever mindful of the ultimate application of that equipment. Therefore, this "custom-built" quality increases efficiency and assures steady, uniform output . . . lower operating and maintenance costs. Users of Robertson Equipment recognize it as an investment in quality, because the finished product assures customer satisfaction and efficient performance . . . Write today for complete information.

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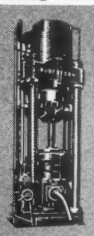
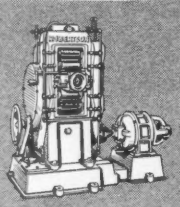
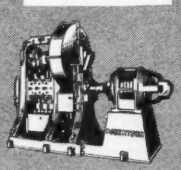


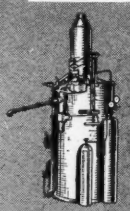
Lead Sheath Stripping Machine



Hydraulic Pump



Closed Lead Melting Pot



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Since 1858

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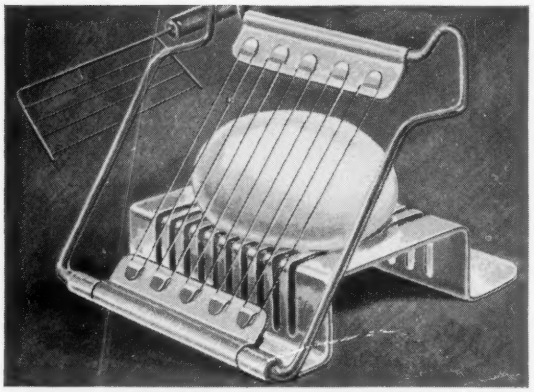
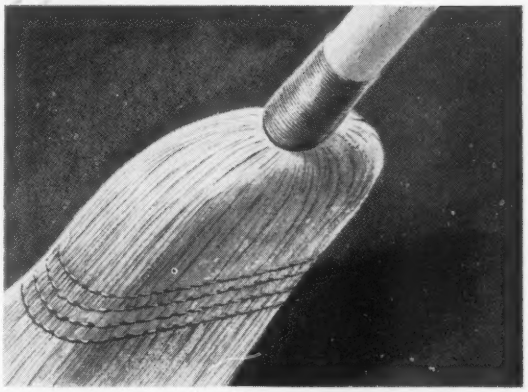
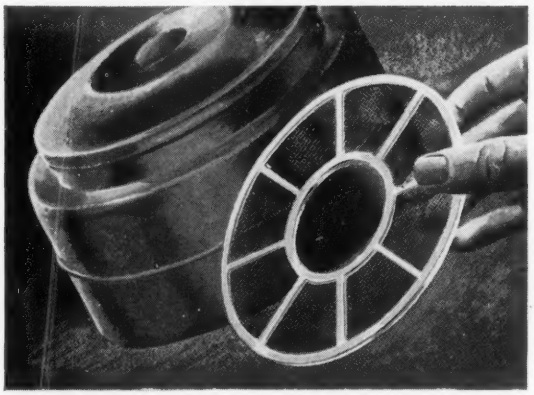
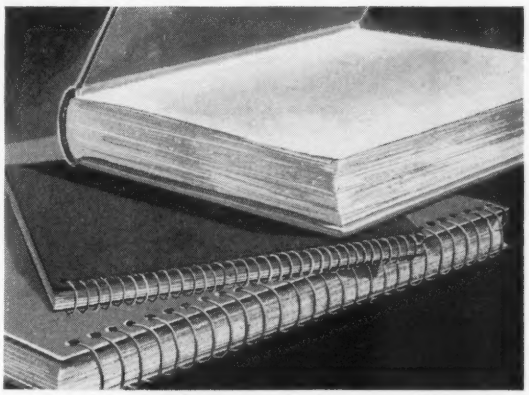




...a versatile fine wire





HERE IS a fine wire that can be tailored to fit *any* need.

It has been used successfully in egg cutters, brooms, engine air filters, books, brushes, staples, vegetable cutters and numerous other products which use fine wire.

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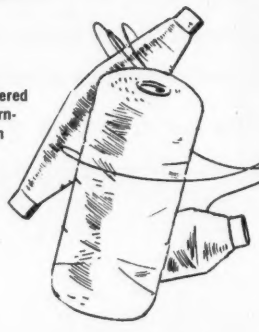

OWENS-CORNING FIBERGLAS *Yarns*

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Fiberglas yarns offer the same advantages when used in building wire

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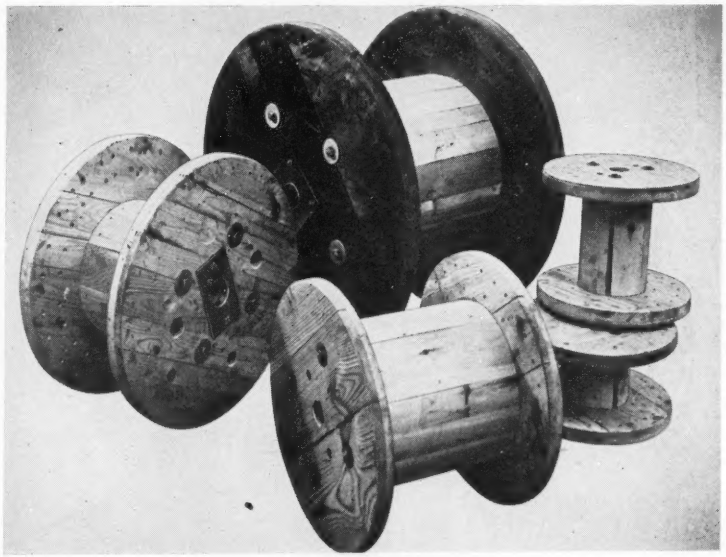

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This service includes over-night delivery of reels, in case of urgent need, direct to your plant. You are invited to avail yourselves of this unique and convenient service.

Send us your specifications and let us quote on costs.

BRIDGE MANUFACTURING CO.

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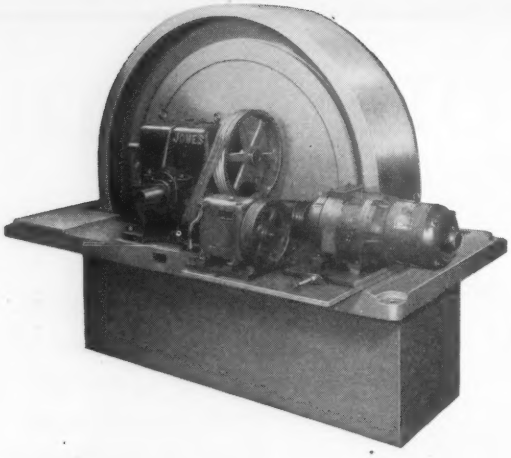
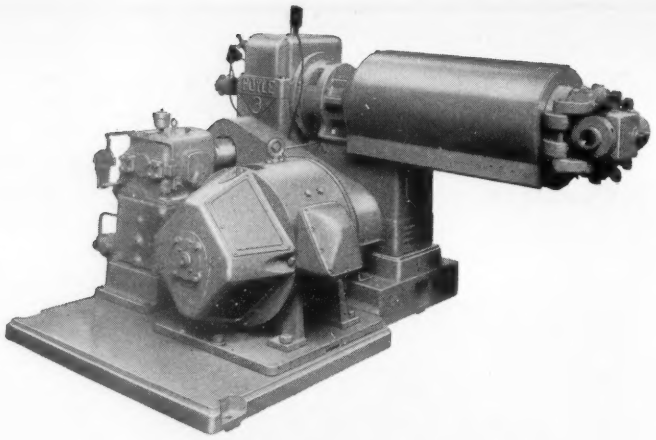
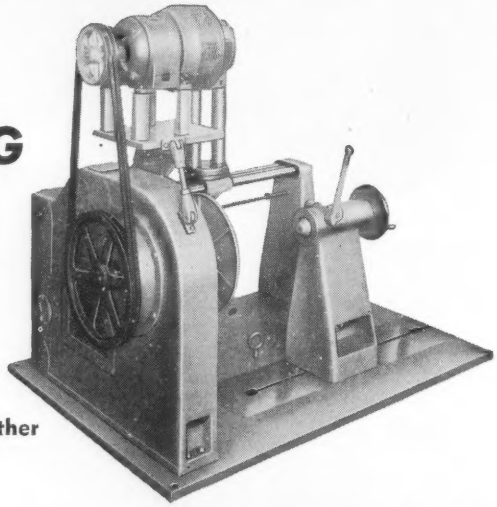




ROYLE

for WIRE INSULATING



- Continuous Vulcanizing Machines for Rubber Wire Insulation
- Plastic Wire Insulation Machines
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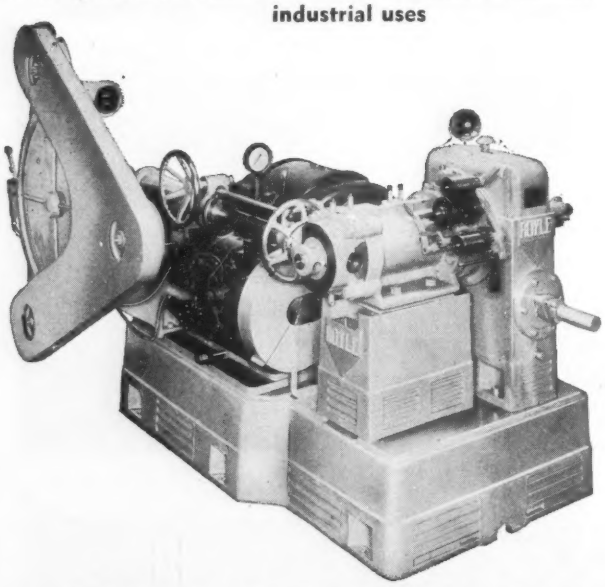

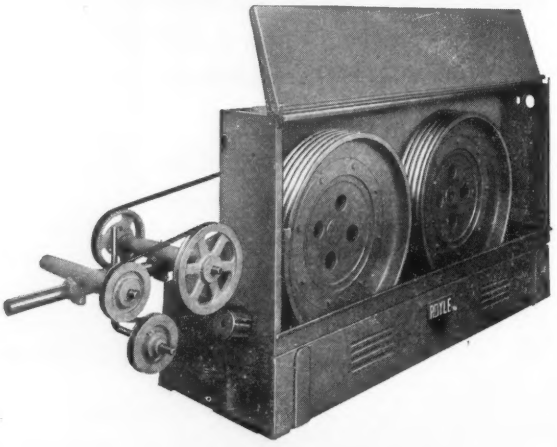

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They Said It Couldn't Be Built . . . but We Did It!

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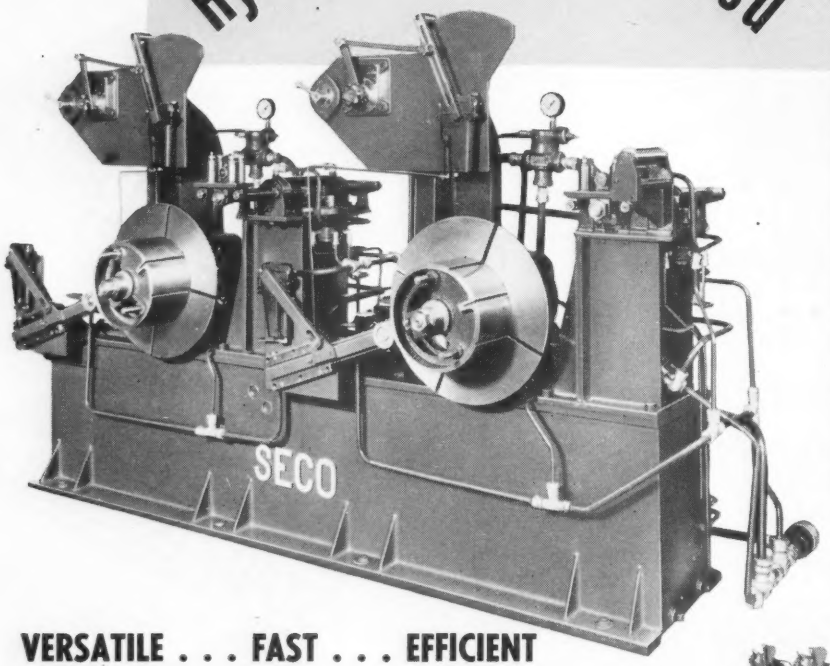
ITS NEW Hydraulically Operated WIRE SPOOLER



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- Quick Speed Adjustment!
- Controlled Tension!
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- High Accuracy!

VERSATILE . . . FAST . . . EFFICIENT

ENTIRELY NEW in DESIGN and ENGINEERING

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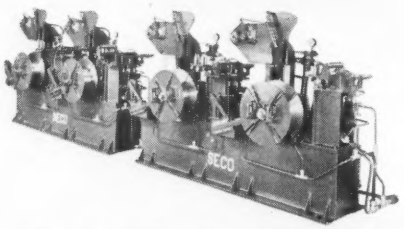

The Four Spindle Duplex Traverse Reel installation shown above handles tinned copper wire at speeds from 150 to 600 FPM. Wire sizes range from .100" thick by .200" wide to .045" thick by .500" wide. Wire is coiled on collapsible blocks, 10" diameter, 6" wide with 18" flanges for 250 pound coils —or on spools with 14" diameter cores, 6" wide with 24" flanges holding 450 pounds of wire. Tension from 75 to 150 pounds is regulated by a pressure control valve.

STEEL EQUIPMENT CO.

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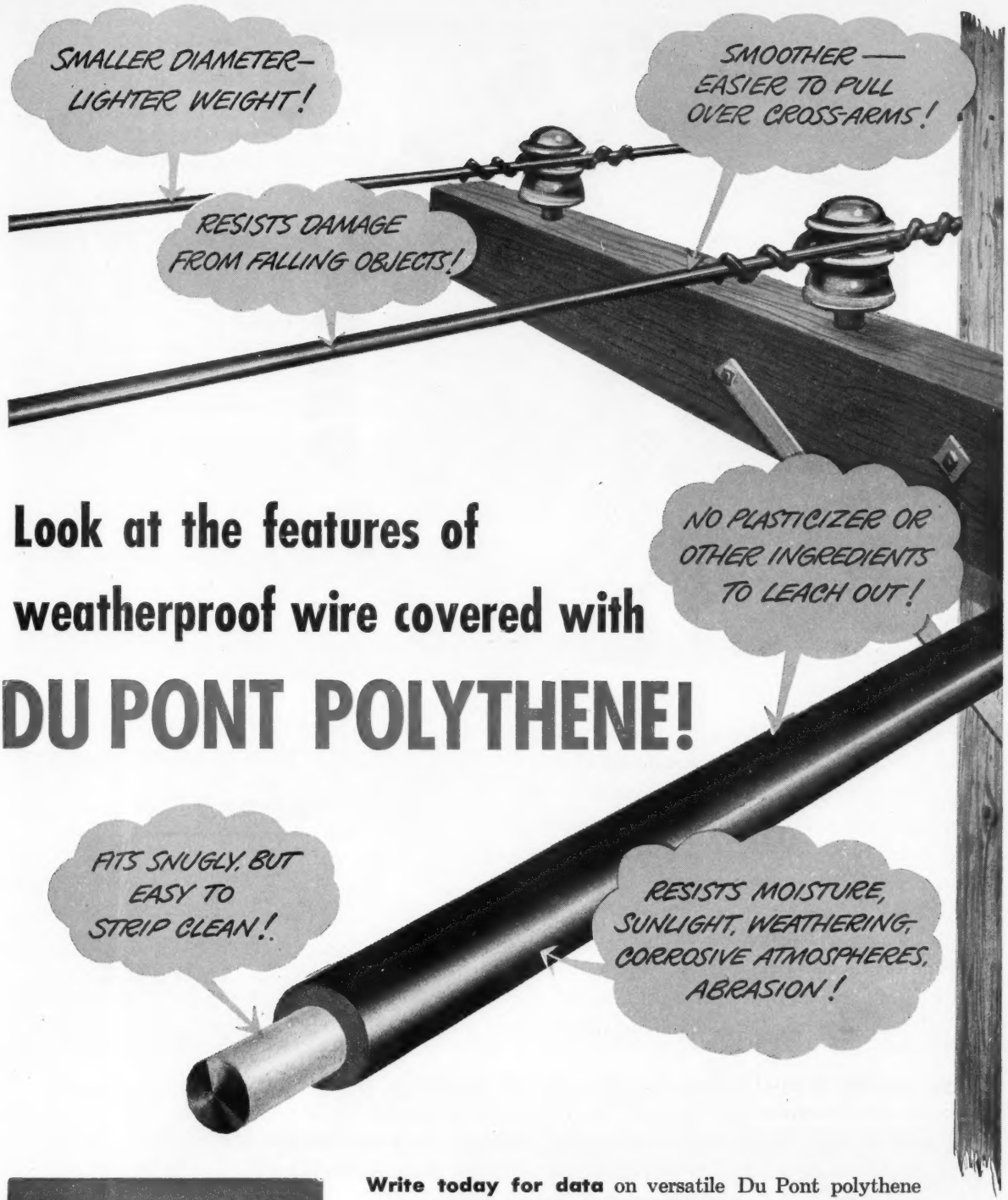
SECO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SMOOTHER — EASIER TO PULL OVER CROSS-ARMS!
RESISTS DAMAGE FROM FALLING OBJECTS!
NO PLASTICIZER OR OTHER INGREDIENTS TO LEACH OUT!
FITS SNUGLY, BUT EASY TO STRIP CLEAN!
RESISTS MOISTURE, SUNLIGHT, WEATHERING, CORROSIVE ATMOSPHERES, ABRASION!

Look at the features of weatherproof wire covered with

DU PONT POLYTHENE!

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UNIFORM IN TEMPER AND TENSILE

In common with other high carbon wires, oil-tempered wire can be as temperamental as an opera star unless it is handled with extreme care. Every step in processing calls for skilled craftsmanship — the kind of handling it gets in the hands of Wissco's many 25-year service men.

It's the knack which our metallurgists and mill men have in handling special wires that has made Wissco Oil-Tempered Wire an old time favorite with spring manufacturers. They like its uniformly high tensile strength and fatigue life.

You can obtain Wissco Oil-Tempered Wire in sizes from .009 to .5625 in coils, with diameters ranging from 8" to 72" and in cut lengths. Or, if you need any other type of high or low carbon steel specialty wire we can supply it. We make it round or shaped, in a wide variety of tempers, grades and finishes. Let us know your requirements.

WISSCO *Wire*

A PRODUCT OF WICKWIRE SPENCER STEEL DIVISION • THE COLORADO FUEL AND IRON CORPORATION

WIRE SALES OFFICE—361 DELAWARE AVE., BUFFALO 2, N. Y.

EXECUTIVE OFFICE—500 FIFTH AVE., NEW YORK 18, N. Y.

SALES OFFICES—BOSTON · CHICAGO · DENVER · DETROIT · NEW YORK · PHILADELPHIA

PACIFIC COAST SUBSIDIARY—THE CALIFORNIA WIRE CLOTH CORP., OAKLAND 6, CAL.

CF&I

"Hey there, tall, drawn and handsome! You look happy enough to be a direct wire to Hollywood."
"Sure thing, pal. I'm a 'live wire' now, thanks to Swift's Soaps. The boss discovered Swift's Soaps are tops for efficient lubrication, minimum dusting and dependable high quality."
"They tell me Swift is one of the most experienced producers of the materials that go into soap. And on top of that, they have the know-how to make quality soap for every wire drawing need."
"That's right! Swift & Company's fats and oils laboratories are among the very best equipped."

There's a Swift Distribution Point near you... to give you fast, efficient service.

Call on Swift for

Powdered White Ribbon
Guaranteed Powder
Snap Heavy Duty Wire Drawing
Powder No. 282
No. 559 Powdered Soap

In barrels and bags

Swift's Soaps

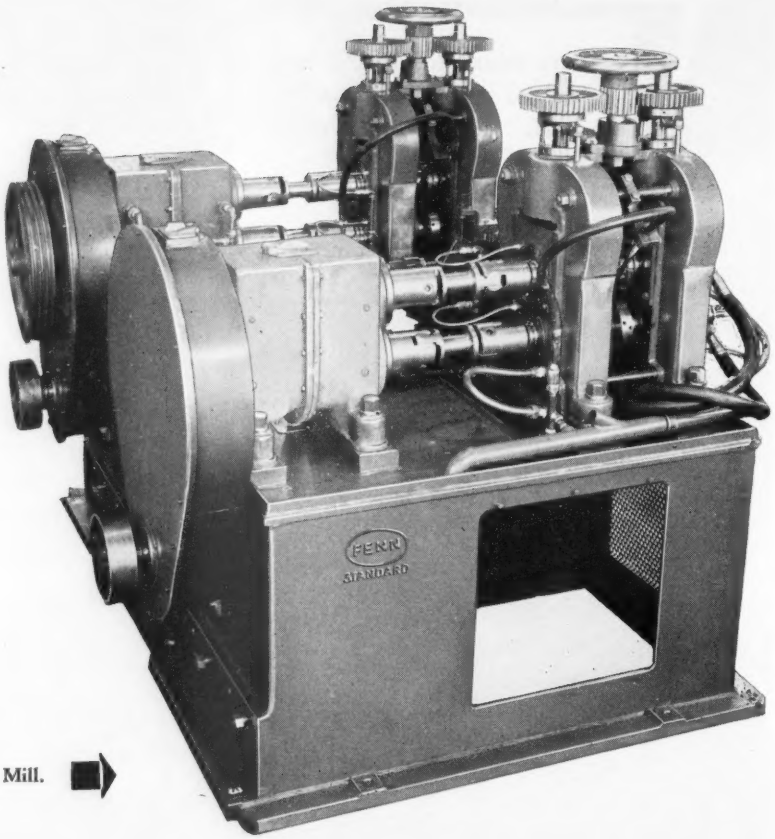
for every wire drawing operation

Swift & Company SOAP DEPARTMENT, CHICAGO 9, ILLINOIS

DO YOU *Flatten*

FLATTEN WIRE IN ONE PASS AT 50 TO 2000 FT. PER MIN.

Fenn-Standard Wire-Flattening Mills Lift Output, Cut Costs in Ferrous and Non-Ferrous Alloys and Stainless Steel.



Fenn-Standard Tandem Wire-Flattening Mill.

Consider the high production and low costs you'll get when a Fenn-Standard Tandem Wire-Flattening Mill takes over the work of your single stands.

Firms that have installed such "one-unit production lines" now do the whole wire-flattening job in a single pass at *speeds up to 2000 feet a minute.* Tandem units with up to 5 stands on single or individual base with roll diameters from 3.5" to 12" cover the whole range of wire sizes in standard ferrous and non-ferrous alloys and stainless steel.

LOOK AT THESE FEATURES

Features like these make such production economy and versatility possible:

Each mill stand driven by herringbone pinion stands through universal joints to the roll necks in order to eliminate chatter marks on the work.

Rolls easily raised and lowered . . . with individual or simultaneous operation of screw downs.

Electric synchronization of rolling speeds from stand to stand.

Pressure lubrication of roll bearings and pinion stands.

Idling or power-driven edgers between stands.

Traversing or ribbon-wind take-ups.

Internal and external cooling of rolls optional for high-speed work.

These are just the highlights of the most efficient wire-flattening method yet devised. It will pay you to look further into Fenn-Standard Wire-Flattening Mills. Write for complete information, or ask for the whole story at the *Wire Association Convention in Chicago—October 17-21.*

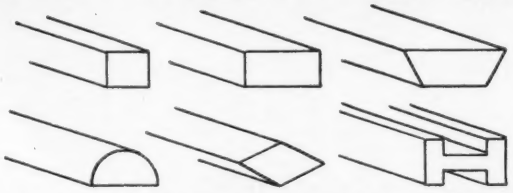
SEE US
at the Wire Association Convention
LA SALLE HOTEL
(Get our Suite number at the desk)
for more information,
or write or wire to . . .

FENN

THE FENN

WIRE OR *Shape* IT?

GET WIRE SHAPES LIKE THESE IN ONE PASS AT 50 TO 1000 FT. PER MIN.



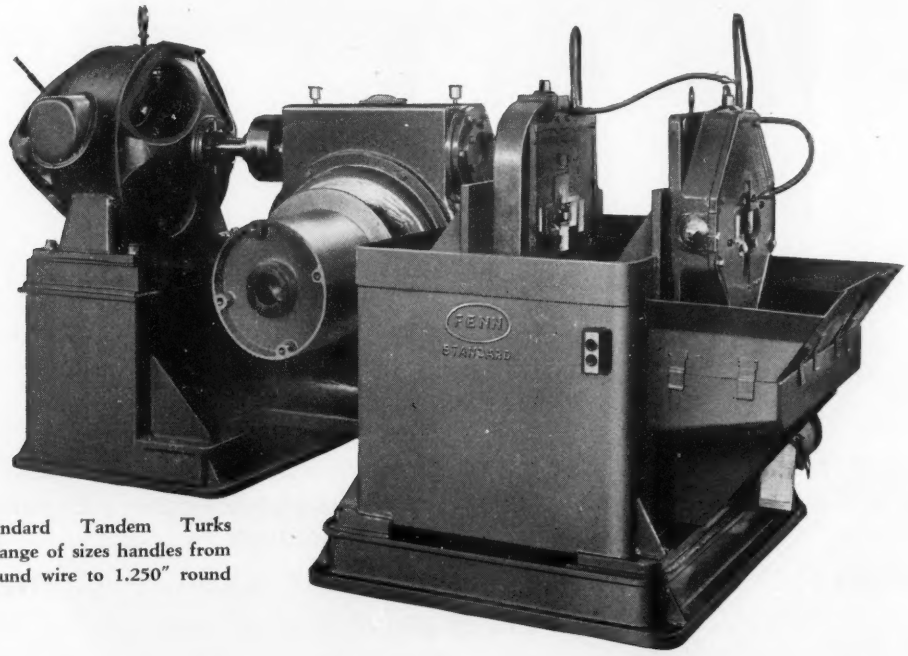
FENN-STANDARD TURKS HEADS CUT YOUR PRODUCTION AND INVENTORY COSTS

From round wire to complete shape in one pass through the machine! That's what you get with Fenn-Standard Tandem Turks Heads, the efficient, low-cost way to form and edge shaped wire in ferrous and non-ferrous alloys and stainless steel.

See how it cuts your costs. One prominent manufacturer is replacing 5 rolling mills with one tandem Turks Head. Another is reducing the number of finished stock sizes because of the ease and rapidity of producing job lots.

It's the high speed and versatility of Fenn-Standard Turks Heads that make such savings possible. You can change the heads of these tandem machines in ten minutes. You can turn out work in a hurry. That means fewer sizes of starting rounds, less raw material and less finished work in stock . . . quicker turn-over of your capital. And remember, you have no heavy investment in dies.

Want all the reasons why Turks Heads, compared to solid dies, give you production at higher rates, fewer passes, greater accuracy, improved metal structure, greater tensile strength? Write for literature, or let's talk it over at the Wire Association Convention in Chicago.



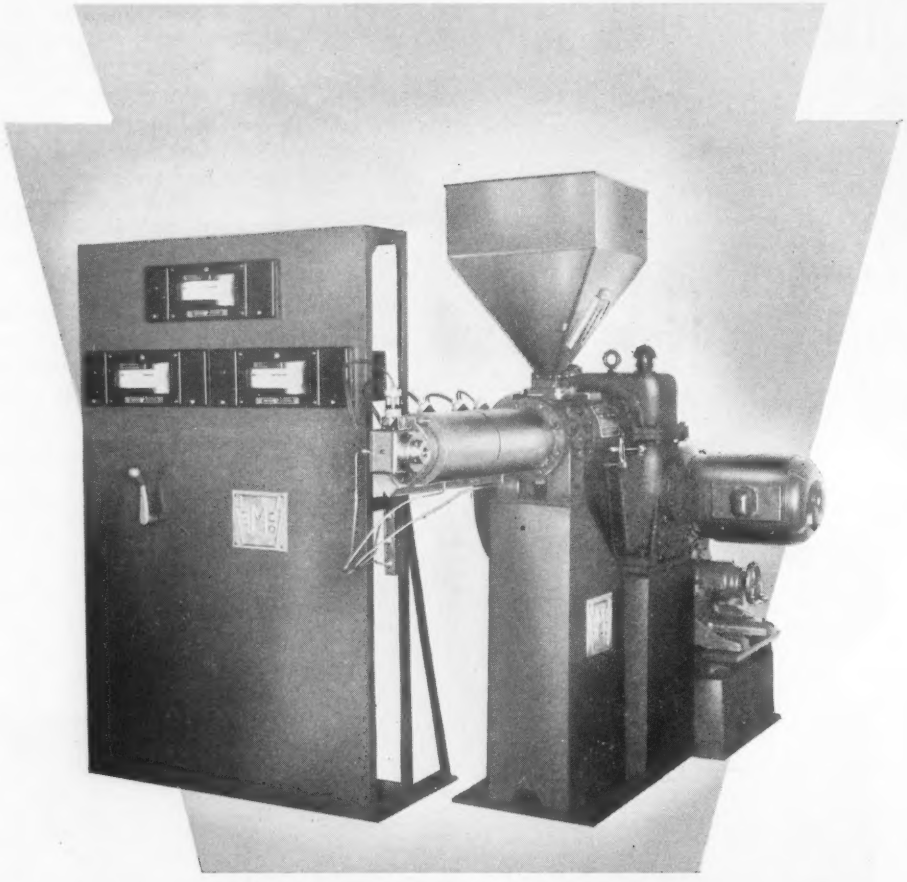
Fenn-Standard Tandem Turks Head. Range of sizes handles from .040" round wire to 1.250" round wire.

MANUFACTURING COMPANY, Hartford 1, Conn.

Announcing the new line of . . .

DAVIS-STANDARD
EXTRUDING MACHINES

New in Design! Advanced in Engineering!



Thermo-Plastic Wire and Cable Insulating Machines. Continuous Vulcanizing Equipment for Electric Wire and Cable and Accessory Equipment. Standard and Special Machines.

COMPLETE ENGINEERING AND MANUFACTURING FACILITIES

Further details will be given in subsequent advertisements. Watch for them!

The STANDARD MACHINERY CO.
Mystic, Conn., U. S. A.

MOSSBERG PRESSED STEEL CORP.

designed

NO-CREV SPOOLS

and **REELS** with

patented **DURA-CURL** rims

providing the ultimate

in strength and durability

P

L

U

S

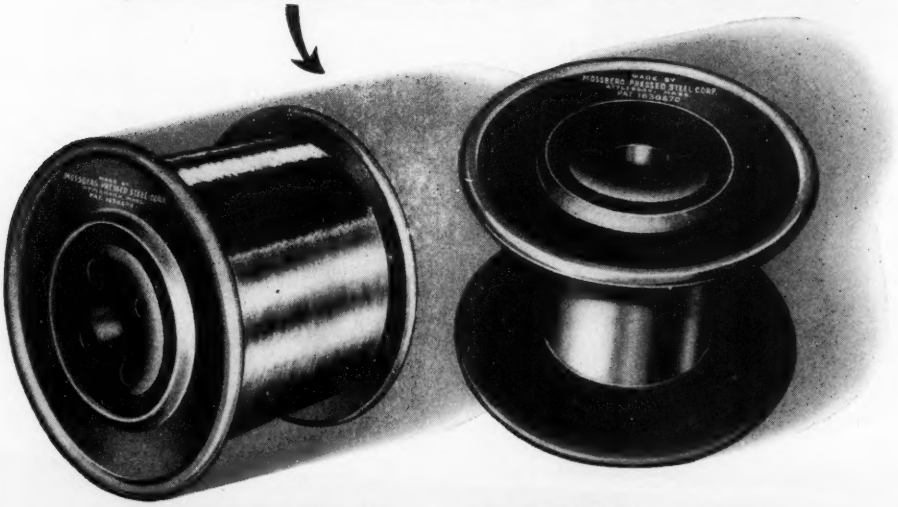
precision and balance for high-speed operation.

FROM THE LARGEST

HEAVY DUTY **BREAK-DOWN-REELS**

TO THE FINEST WIRE —

NO-CREV DESIGN SPOOLS



These developed refinements mean *trouble-free-winding.*

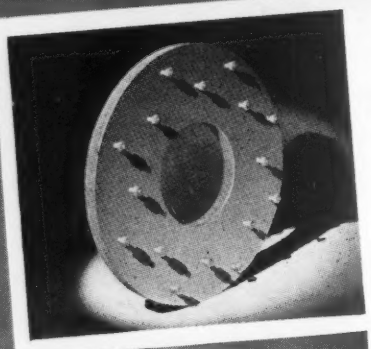
GREETINGS 1949

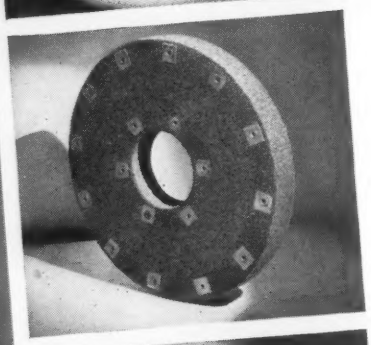
MOSSBERG PRESSED STEEL CORP.

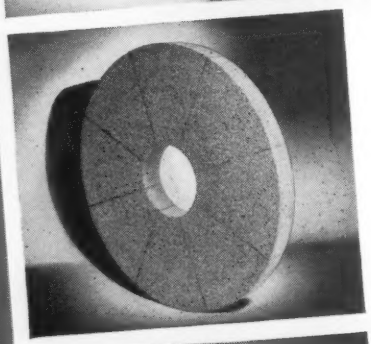
18 WEST STREET ATTLEBORO, MASSACHUSETTS, U.S.A. Telephone Attleboro 1-0847 & 1-0848

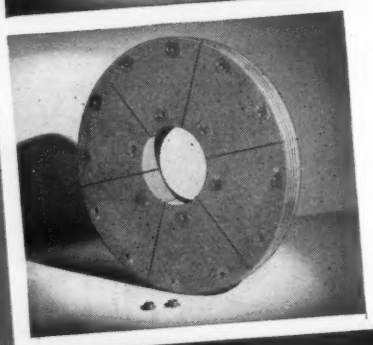
James Day (Machinery), Ltd., 90 Regent Street, London, W. I. England

A Disc of the Right Combination . . for Every Spring Grinding Job!









That's What NORTON Offers You!

- **Right Combination Means**—A disc of: (1) the **right abrasive**—fast, cool-cutting 32 ALUNDUM, or sharp, tough 57 ALUNDUM abrasive; (2) the **right bond**—vitrified; (3) the **right grain size;** (4) the **right grade;** (5) the **right structure**—Open or "P" Type; and (6) the **right type of mounting.** Norton discs are available in many different combinations of these six important elements. There's a disc which will cut fast and cool, wear evenly, resist grooving, and require a minimum of dressing for each of your spring grinding jobs.

- **Several Disc Types Available**—The first two illustrated here—solid plate mounted and solid inserted nut—are recommended for grinding small, or medium diameter wire springs where pressure and heat generated are moderate. The second two types —segmental plate mounted and segmental inserted nut—are recommended for grinding jobs on heavy or large diameter wire springs where considerable pressure is used and high temperatures are generated.

- **Take Advantage of Norton Service**—Let a Norton abrasive engineer study your spring grinding jobs. He'll take into consideration the type of grinder used, the method of operation, the material ground, the size and shape of the work, and the finish desired. Then he'll recommend a Norton disc of the **right** combination.

NORTON COMPANY • WORCESTER 6, MASS.

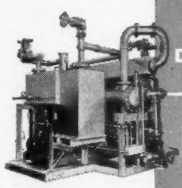
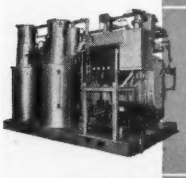
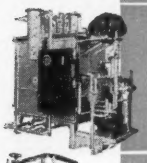
Distributors In All Principal Cities

W-1222

NORTON®
ABRASIVES

'Surface' PREPARED Gas Atmospheres

...for every heat treatment of ferrous and non-ferrous metals

TYPE OF GAS	* SIZES OF AVAILABLE UNITS	METAL TO BE TREATED				
		COPPER	LOW C. STEEL UP TO 0.20 C.	MED. C. STEEL 0.20-0.60 C.	HIGH C. STEEL ABOVE 0.60	SPECIAL STEELS
 **DX GAS** (LEAN) 40° F. DEW POINT	250 TO 35,000 CU. FT. PER HOUR	BRIGHT ANNEAL	———	———	———	———
DX GAS (RICH) 40° F. DEW POINT	250 TO 35,000 CU. FT. PER HOUR	———	BRIGHT ANNEAL	UP TO 30 MIN. EXPOSURE BRIGHT ANNEAL AND CLEAN HARDEN	———	———
 **NX GAS**	1,000 TO 20,000 CU. FT. PER HOUR	BRIGHT ANNEAL	BRIGHT ANNEAL	BRIGHT ANNEAL CLEAN HARDEN	BRIGHT ANNEAL CLEAN HARDEN	———
 **RX GAS**	250 TO 3,500 CU. FT. PER HOUR	Oxygen, O_2, is the only one of the common gases which reacts with copper, consequently, the atmosphere generator may be dispensed with in the bright annealing of that metal. It is only necessary to set the furnace burners slightly rich to prevent free oxygen within the furnace.	CARBURIZE DRY CYANIDING	CARBURIZE BRIGHT ANNEAL CLEAN HARDEN CARBON RESTORATION (SKIN RECOVERY) DRY CYANIDING	BRIGHT ANNEAL CLEAN HARDEN	———
CHAR-MO GAS	500 TO 1,000 CU. FT. PER HOUR		CARBURIZE	CARBURIZE BRIGHT ANNEAL CLEAN HARDEN	BRIGHT ANNEAL CLEAN HARDEN	CLEAN HARDEN TUNGSTEN MOLYBDENUM STEEL
AX GAS (DISSOCIATED AMMONIA)	500 TO 4,000 CU. FT. PER HOUR		———	———	———	BRIGHT ANNEAL STAINLESS STEEL

*Where larger capacities are required multiple units can be supplied.

● Surface Combustion research in the development and use of specially prepared gas atmospheres for all heat treatments of ferrous and non-ferrous metals has made possible metallurgical results of such significance that it goes beyond the mechanical details of furnace construction.

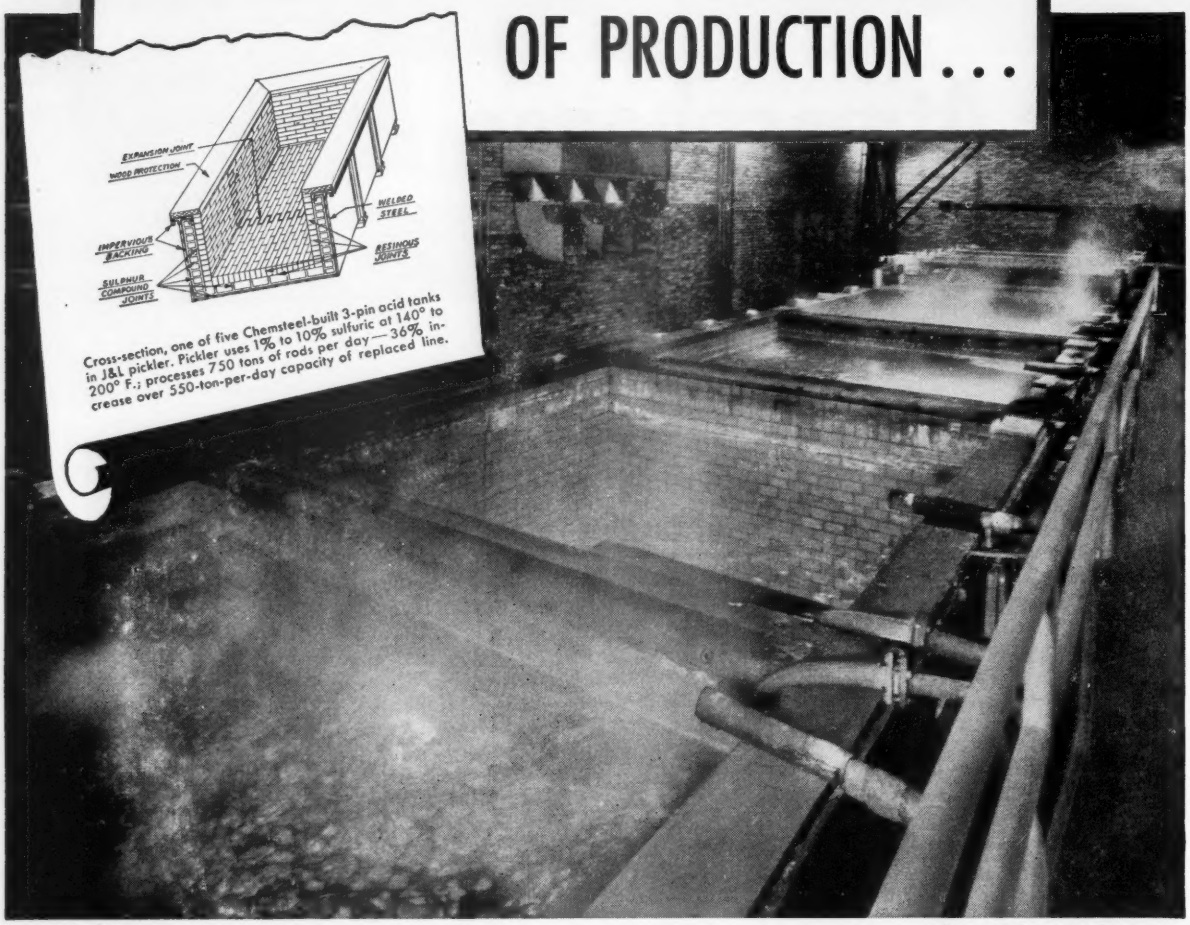
Today, with the use of 'Surface' indirectly heated furnaces—radiant tube heating elements and muffle type units — and Surface' Prepared Gas Atmospheres, all metal surfaces can be treated to prevent undesirable effects or to produce surface conditions as required.

FOR PREPARED GAS ATMOSPHERE COMPOSITIONS, COSTS, AND DETAILS OF APPLICATIONS

write for booklet, "The Science of Gas Chemistry for Heat Treating" Form SC-129.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

J & L PICKLER Meets the Acid Test OF PRODUCTION . . .



Cross-section, one of five Chemsteel-built 3-pin acid tanks in J&L pickler. Pickler uses 1% to 10% sulfuric at 140° to 200° F.; processes 750 tons of rods per day—36% increase over 550-ton-per-day capacity of replaced line.

Courtesy B. F. Goodrich Co.

CHEMSTEEL ACID-PROOF CONSTRUCTION MINIMIZES TANK MAINTENANCE

The modern wire pickler at Jones and Laughlin Steel Corporation's Aliquippa Works called for specialized construction techniques and special materials. Its five 3-pin acid tanks had to be protected from destructive action of sulfuric acid and light alkalies at working temperatures up to 230° F.—as well as from thermal shock, abrasion and mechanical abuse—in order to assure low maintenance costs and uninterrupted production.

Chemsteel Construction Co., Inc., effectively met these requirements. After assisting in design and material selection, Chemsteel engineers protected the five rubber-lined, welded steel tanks with an 8" sheathing of acid-proof brick joined by high-temperature, acid-proof cement. Chemsteel also effected savings in time and money by its efficient installation of the pickling tanks in minimum time.

You, too, can profit by Chemsteel specialized construction services. Backed by wide and varied experience serving major steel, chemical, textile and food plants, Chemsteel will design, select and obtain materials, and erect new corrosion-proof construction . . . handle maintenance work . . . or work cooperatively with your engineering firm or contractor in any one of these functions.

For complete details write for Bulletin C-1.

CHEMSTEEL CONSTRUCTION CO. INC.

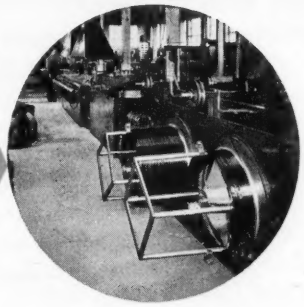
5428 Walnut St., Pittsburgh 6, Pa. · Telephone MUseum 1-7500

THE *Trauwood* PROCESS IS SETTING A NEW "WIREBOUND" TRADITION!!

QUALITY, UNIFORMITY, LOW-COST OPERATION

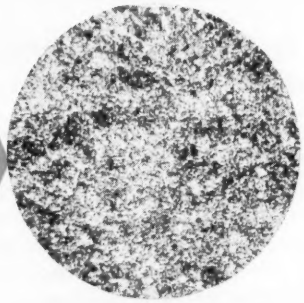
★ The electric resistance heating used in our process is over 90% efficient and results in a uniformly heat treated product plus the ability to duplicate exact heating and quenching cycles from day to day. Positive circulation in the molten metal quench bath insure absolute uniformity of the wire.

FASTER PRODUCTION FULLY AUTOMATIC



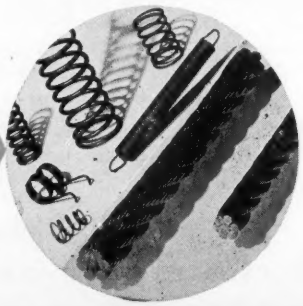
★ The TRAUWOOD process is much faster than ordinary furnace heating due to the very rapid rate of electric resistance heating. The equipment is entirely automatic and is easy to operate. Greater production with a material reduction in pickling and cleaning costs is insured.

BROAD THERMAL RANGE ACCURATE CONTROL



★ The finer grain produced by TRAUWOOD electric resistance heating develops the maximum physical and fatigue properties in any steel in either patenting, tempering or annealing. The annealing of stainless steel and other alloy wire and strip is readily accomplished since the high quenching temperatures necessary are easily and rapidly attained.

CAN BE DESIGNED FOR ALL SIZES AND TONNAGES



★ The TRAUWOOD process, in addition to doing a better wire heat treating job, is opening new fields of application for the wire industry. The equipment is designed to meet your specific requirements and can be built to handle all sizes in any tonnage required. Full information will be furnished on request.

Patented in U.S.A. and Foreign Countries

THE TRAUWOOD ENGINEERING COMPANY

15200 BROOKPARK ROAD • BOX 2719 WESTPARK STATION • CLEVELAND, OHIO

JOHN RIGBY & SONS, LTD., LOW MOOR, BRADFORD - YORKS. ENGLAND — BRITISH REPRESENTATIVE
LABORATOIRE ELECTRONIC CENTRAL, 12 RUE SIMONON, LIEGE, BELGIUM—BELGIAN REPRESENTATIVE

Two New IOI Developments In Plastic Wire Jacketing

1 A Complete Heavy Duty Extrusion System for 6 Gauge to 1¾ Inch Cable, Featuring Continuous Operation During Reel Changes.

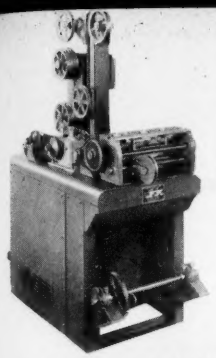
This latest IOI advance in extrusion takeup equipment provides *continuous* plastic or rubber jacketing of flexible cables up to 1¾ inches in diameter. The system is equipped with constant tension accumulators into which the cable feeds while the takeup reel is being changed. On system speeds up to 300 feet per minute the accumulators allow the operator 20 seconds for making the cut and starting the new reel. With IOI letoff and takeup accumulators, it is possible to run continuously for any period of time without shutdown. The first IOI system of this type has been in almost continuous operation for the last nine months.

2 New Plastic Line for 6 to 24 Gauge Wire, Featuring a 3½ Inch Plastic Tuber and Complete Constant Tension Drives.

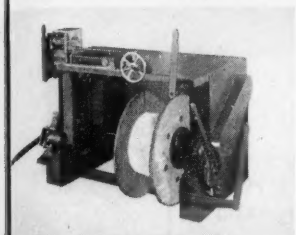
This system has a speed range of from 50 to 1600 feet per minute with true constant tension wire handling over the entire range. It embodies such advanced wire handling equipment as a driven payoff, a constant tension capstan and a separate continuous takeup unit. It employs a 3½ inch plastic tuber. The entire system is powered by a complete variable voltage drive which in turn operates hydraulically controlled tensioning and synchronizing equipment.

Complete information on these systems and the other IOI equipment shown on the opposite page will be sent upon request. Also write for recent IOI booklets for the wire industry, "Blueprint for Industry Part IV, Continuous Extrusion Equipment" and "The Handling of Webs and Monofilaments."

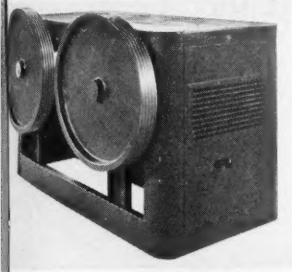
INDUSTRIAL OVENS, INC.
13825 TRISKETT ROAD — **CLEVELAND 11, OHIO**



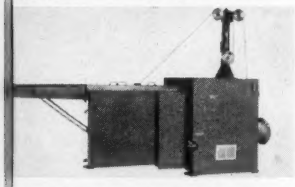
SINGLE REEL TAKEUPS



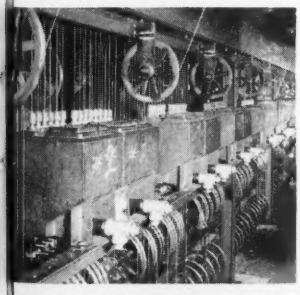
CONTINUOUS TAKEUP



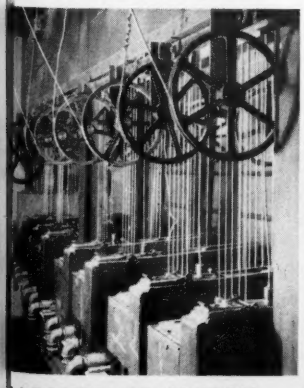
DOUBLE DRUM CAPSTAN



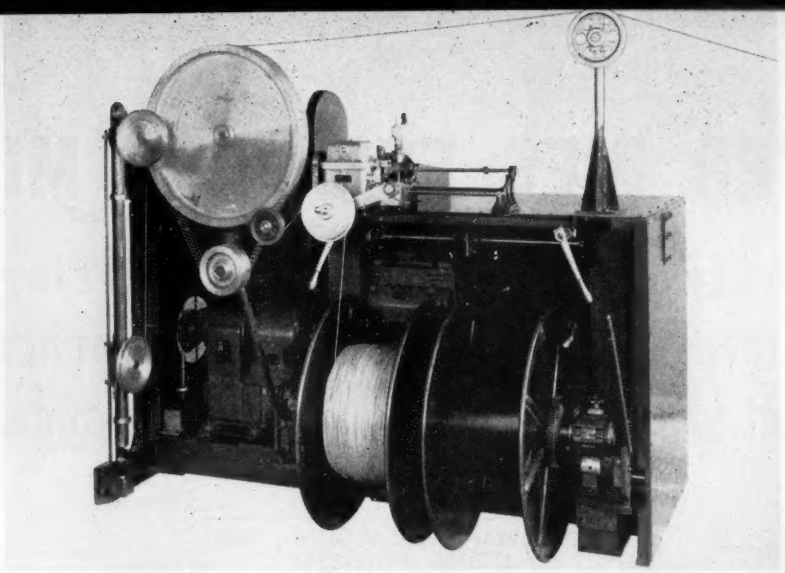
TUBING TAKEUP



LACQUERING SYSTEM



LACQUERING SYSTEM



CONTINUOUS TAKEUP WITH INTEGRAL CAPSTAN

INSULATED WIRE MACHINERY

COMPLETE EXTRUSION SYSTEMS

CONTINUOUS TAKEUPS — CORD PRE-DRYERS

LACQUERING SYSTEMS — ENAMELING MACHINES

PROCESS ANNEALERS — DRAW BENCH TAKEUPS

ASBESTOS INSULATING MACHINES

SATURATING AND FINISHING SYSTEMS

● IOI Equipment is used in the largest Wire Mills in the world. If you have a problem in this field it will pay you to consult **IOI.** Write for complete information.

INDUSTRIAL OVENS, INC.

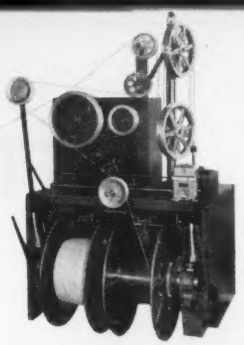
13825 TRISKETT ROAD — CLEVELAND 11, OHIO

ASSOCIATED COMPANY• JAMES DAY MACHINERY LTD., LONDON, W. 1, ENGLAND

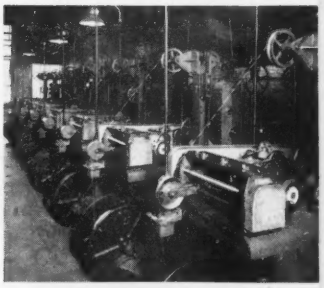
COOLING TROUGH

COOLING TROUGH

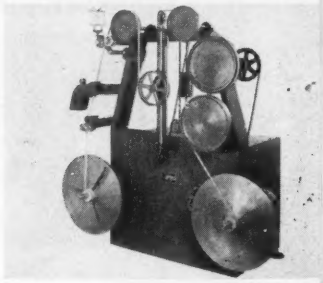
BATTERY OF 24" REEL CONSTANT TENSION TAKEUPS



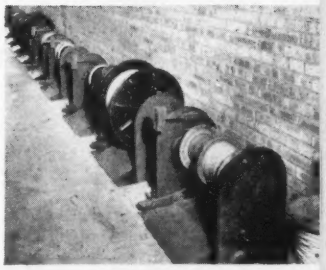
DUAL REEL TAKEUP



SINGLE REEL TAKEUP



STRIP TAKEUP



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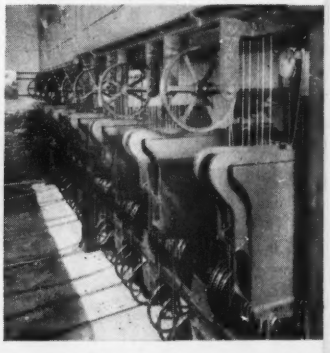
WIRE PRE-ANNEALER



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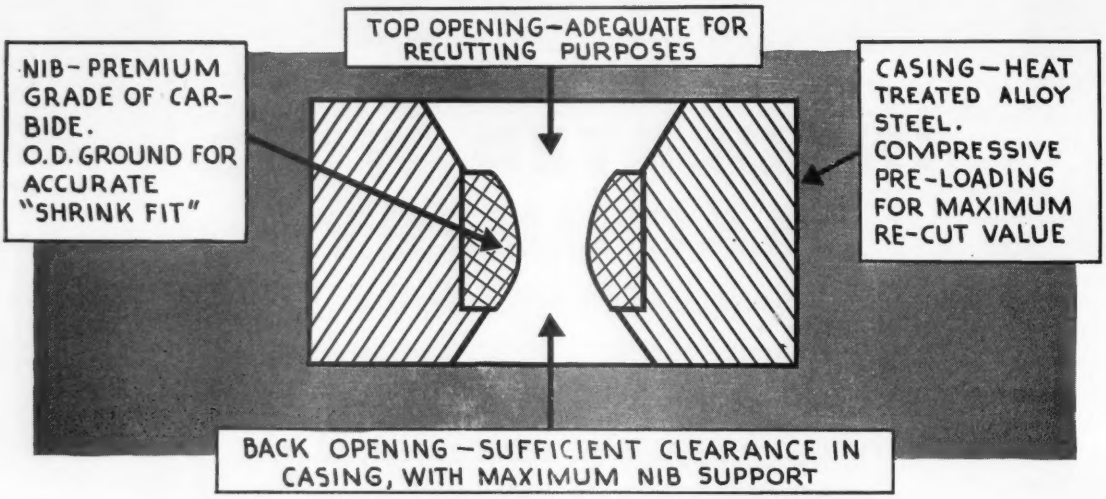
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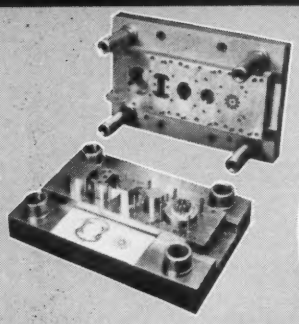
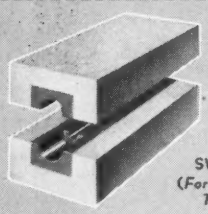


PIERCING AND LAMINATION DIES



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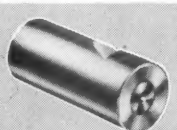

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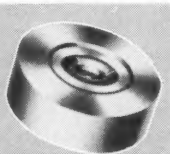

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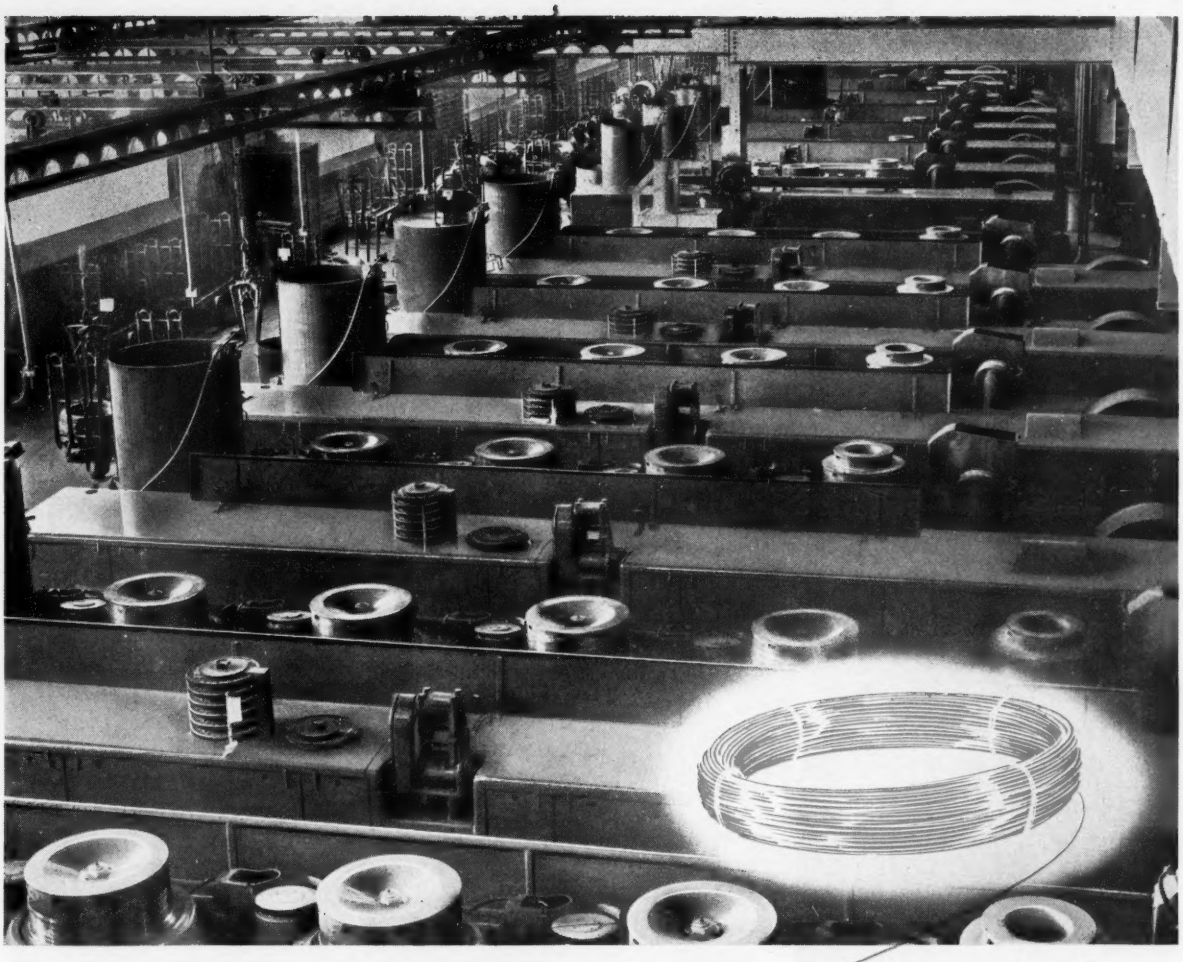

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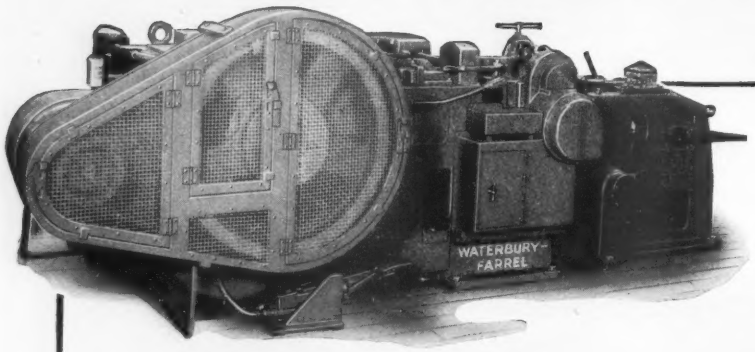
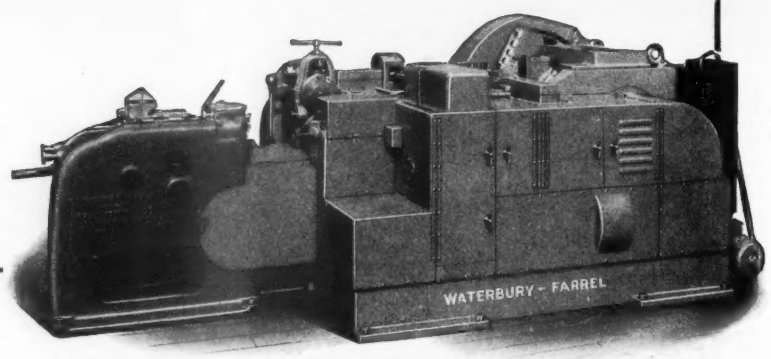
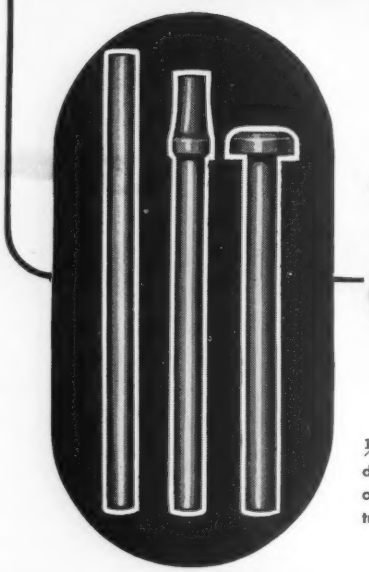


Waterbury "Hi-Pro" header with AJAX-HOGUE wire drawer attached.

Other side of same header showing AJAX-HOGUE drawer at left.





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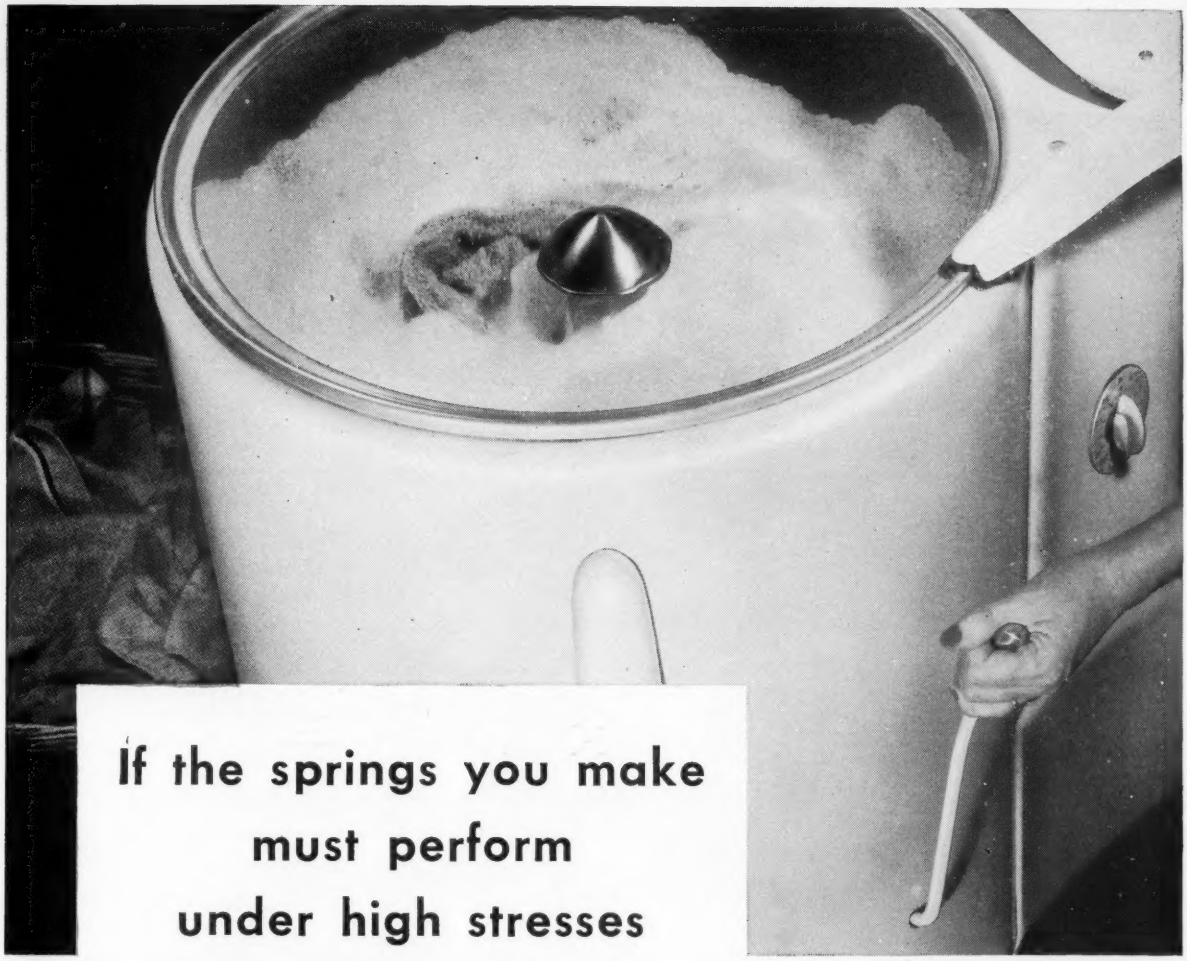

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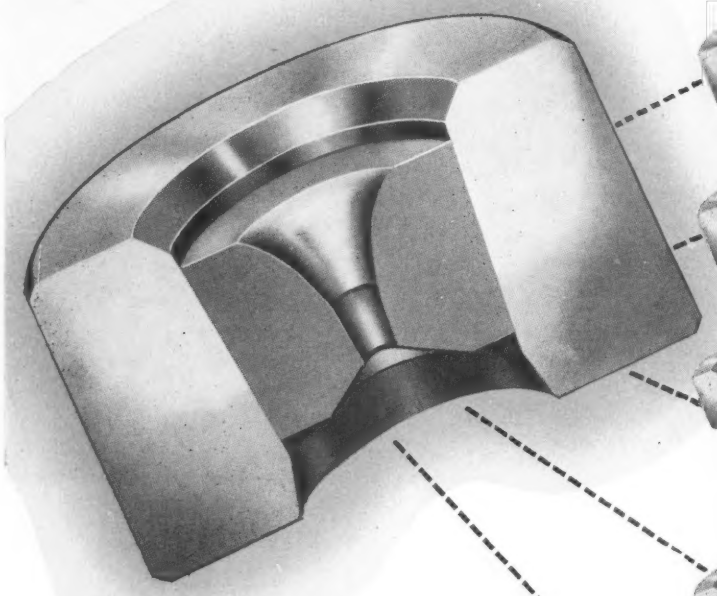

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The Wire Outlook

Demand for steel continues to improve and has exceeded the most optimistic forecasts of mid-summer. While purchasing continues to be for short-range needs only, a recent survey among purchasing agents indicates a general belief that business will gather momentum, although continuing somewhat hesitant until major labor cost problems are settled.

In the steel fact-finding investigations we have witnessed an attempt by organized labor, working through the Government, to undermine the free enterprise system by unprecedented measures. It was apparent that labor, although it did not win a recommendation for wage increases, has more power than is healthful for a sound economy.

Since 1939, while steel wages advanced 116%, the cost of living rose only 71%, yet the labor moguls had the temerity to demand a "fourth round," well knowing the probable set-back to recovery that might ensue. The power to destroy possessed by labor, who have exhibited either a vast ignorance or a selfish disregard of those principles that have made America a great and strong nation, is still a menace to freedom and prosperity. All that has been accomplished at this writing is a deferment of the demands plus a truce in the strike threat.

What is deplorable in this case is that the machinery of Government was used to settle a question that should have been composed by direct negotiation. It is another step toward Federal regimentation of private affairs in the direction of totalitarianism.

Poor old England is having its difficulties. Their Socialist Government has nationalized three major industries and has thus removed them from the ranks of taxpayers to deficit producing industries that in 1948 cost the British public over 300 million dollars. England can't take such bureaucratic inefficiency—nor can any other nation.

While our sympathy goes out to those sturdy industrialists who are struggling against a trying situation, the hard fact is that the British nation's troubles might be the more speedily corrected if the Labor Government were required to sink or swim on the efficacy of their chosen course, instead of depending on our largess to bolster an impossible theory of government. It is said, however, that both labor and management have further contributed to the economic dilemma through restrictive regulations that help to keep production costs too high for a ready British participation in competitive world markets. Devaluation of the pound will doubtless help her exports, although this one measure seems to be only a partial answer to the basic problems with which England is confronted.

Our good neighbor, Canada, on the other hand, has not yet experienced a severe industrial slump, or readjustment period. We sincerely hope that the plight of England will not be reflected in her future operations, which are run on a free enterprise basis similar to our own.

In the wire field, the F.O.B. pinch is beginning to hurt those mills whose production facilities are not widely distributed. Some few concerns have abandoned F.O.B. pricing for the old basing point system to overcome the freight obstacles. While not illegal, it would be helpful to industry in general to have basing point pricing methods authorized by statute.

Wire product demand is holding well, with nail sales good as a result of building activity. Screw machine manufacturers are doing better and bolt, nut and rivet sales have improved, although not enough to warrant stepped-up production schedules. Woven wire fencing and barbed wire are entering a normal seasonal decline in volume. Manufacturers' wire sales have improved and a better demand for wire rods has been noted as non-integrated mills have increased operating schedules. An unexpected upturn in spring wire has developed from furniture manufacturers.

Copper, lead and zinc prices are holding steady, with no special increase in demand. The steel wage negotiations are having a deterrent effect on buyers, who will not add to inventories in the face of a prospect of being unable to get steel.

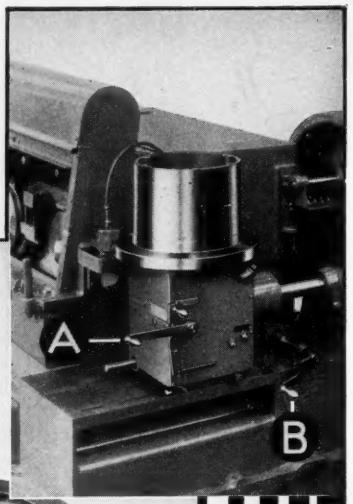
Business should continue to become increasingly better, barring major strikes. A more optimistic note pervades industry that it is to be hoped circumstances will justify.

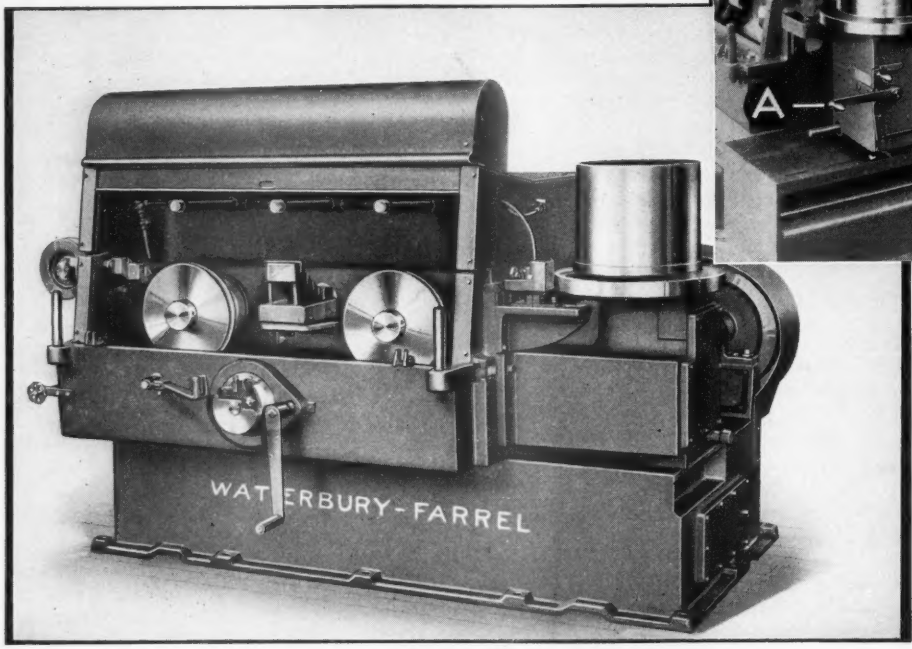
Let our President and members of the Congress take heed that unless loyalty to American freedom and institutions becomes their first and only concern, a ruthless and despotic dictatorship can and may arise here that could destroy all that makes life worthwhile in these good United States.

May we extend to those attending the forthcoming Twentieth Annual Convention of The Wire Association a hearty greeting and a cordial welcome.

—from the Editor's Desk

WIRE DRAWING MACHINES





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A monthly publication devoted to the production of Wire, Rod and Strip, Wire and Rod Products and Insulated Wire and Cable.

DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 24 OCTOBER, 1949 No. 10

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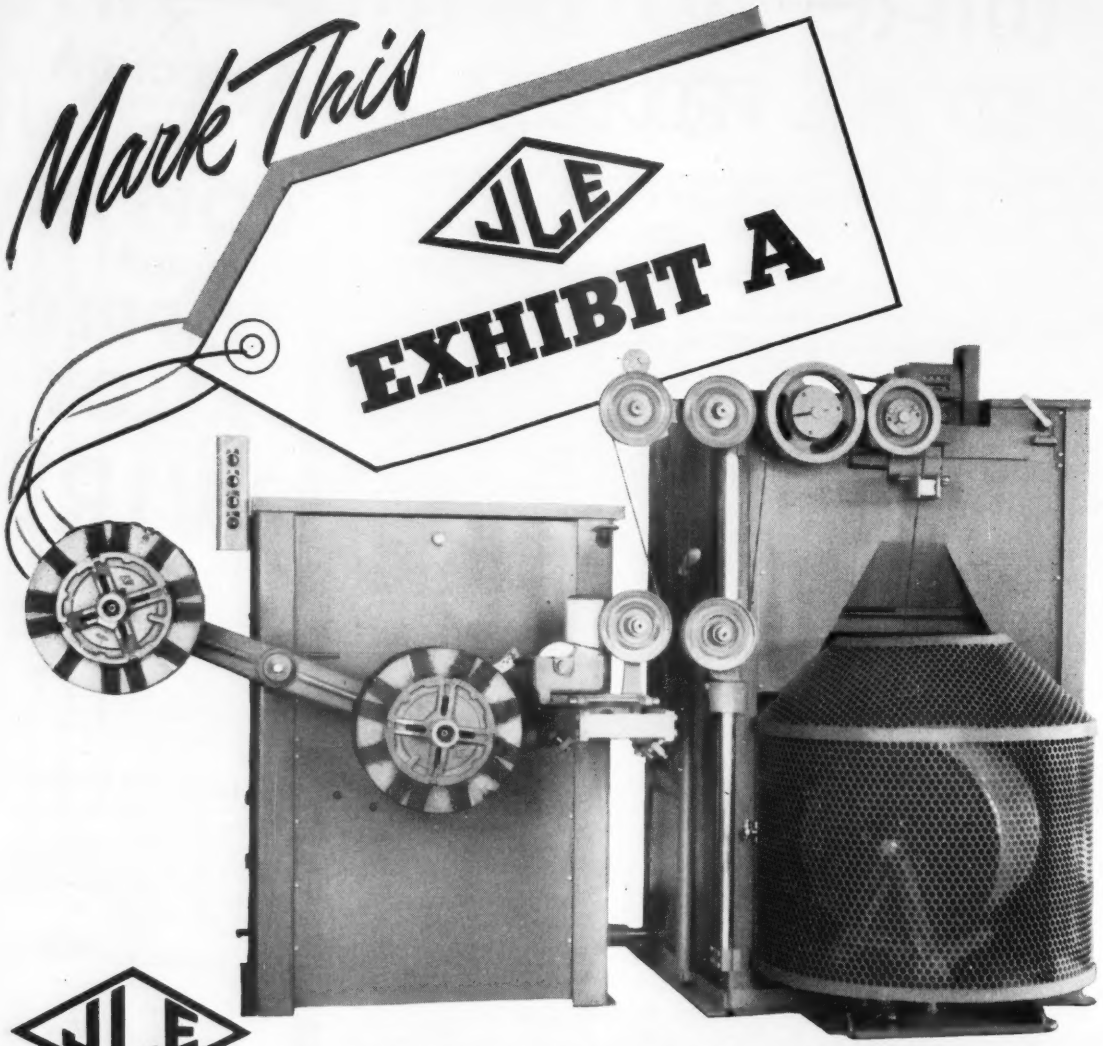

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WIRE AND WIRE PRODUCTS

A monthly publication devoted to the production of Wire, Rod and Strip.
DRAWING — ROLLING — EXTRUDING — FORMING — FABRICATING

Vol. 24 OCTOBER, 1949. No. 10

Protective Atmospheres For Annealing Non-Ferrous Wire

By E. G. de Coriolis, Director of Research and O. E. Cullen, Chief Metallurgist

Surface Combustion Corporation, Toledo, Ohio

WHEN we speak of protective atmospheres for annealing non-ferrous metals in any form, we must of necessity cover a varied field of atmosphere generators. In addition, we must describe to a considerable extent, the heat-treating furnaces in which annealing processes are carried out. This will be readily appreciated by those who are conversant with the annealing of non-ferrous metals and who are familiar with the effects of the various components of atmospheres when used in conjunction with the heating and cooling of non-ferrous materials of widely different chemical analysis.

E. G. deCORIOLIS

E. G. deCoriolis was graduated from the University of Toronto. His earlier career was devoted to the chemical industry. Chief Engineer of Arthur D. Little, Inc., Consulting Chemists and Engineers, Boston, during World War I when the organization was drafted by the Chemical Warfare Service to work on gas defense. Subsequently, he has carried on consulting practice in Boston, specializing in fuels.

He joined Surface Combustion Corporation in 1925 and since 1929 has been Director of Research.

★ ★ ★

THERE was a time when the term "protective atmosphere" implied little more than supplying atmosphere for heating and cooling metal without excessive oxidation of the surfaces. In other words, a protective atmosphere was adjudged successful if it did nothing more than prevent the formation of sufficient oxide or scale to materially change the cross section of the metal during subsequent pickling or other descaling operations.

★ ★ ★

GRADUALLY, the meaning of "protective atmospheres" has changed. In the non-ferrous field, it almost universally describes means for the complete elimination of scale or measurable oxide from the metal surfaces. In fact, in the case of most non-ferrous metals, it is understood that protective atmospheres will permit heating to annealing temperature

O. E. CULLEN

O. E. Cullen was born in Wayne, Michigan. He graduated from the University of Detroit with the degree of Metallurgical Engineer. His first experience in the field of atmospheres was obtained as experimental engineer for the Atlas Chemical Company of Toledo, Ohio. Thereafter, he spent several years with the General Reduction Corporation, in Detroit, specializing in problems relating to the production of metal powders from their nature ores.

Since 1936 he has been employed by the Surface Combustion Corporation as engineer in Research and Development and later as Chief Metallurgist.

and subsequent cooling with the product as bright or even brighter than when it entered the annealing furnace. The terms "bright annealing" and "protective atmosphere annealing" often times are considered synonymous in discussing the heat-treatment of non-ferrous metals and alloys. Such is not always true and it should be understood that large quantities of non-ferrous wire and other products are being annealed in truly protective atmospheres which eliminate the formation of measurable scale but do permit formation of sub-microscopic surface oxide films. These films may alter the color or appearance of the metal. They may be desirable because of their color or their benefits in subsequent working operations. In other cases, they may be tolerated due to economic advantage of using simply prepared protective atmospheres plus flash pickling rather than utilizing a truly bright annealing atmosphere of higher cost. This question of economy may depend upon the analysis of the non-ferrous metal or alloy, and in many cases upon the physical form of the work. The cross section of the wire, its treatment in coiled or strand form and the degree of cleanliness of the material to be heat-treated are factors to be considered.

★ ★ ★

Choice of Atmosphere

IN any discussion of protective atmospheres for non-ferrous metals or alloys the first problem is consideration of the various constituents in the metal and the effects of different gaseous elements or compounds upon these constituents throughout the range of heat-treating temperature. The metallic elements involved may include copper, nickel, zinc, beryllium, silicon, gold, silver and others. These elements or mixtures thereof present widely different protective atmosphere requirements. Each one must be considered separately not only with regard to the atmosphere used, but also with regard to the type of furnace as this affects the proper use of the atmosphere.

★ ★ ★

WHAT makes an atmosphere protective? To the uninitiated, the answer is as simple as this: eliminate all elements or compounds which are non-protective. To those experienced in the art of annealing non-ferrous metals, this is not always too easy to accomplish. Absence of undesirable constituents in the annealing furnace depends upon three precautionary measures. The correct atmosphere must be chosen in the first place. Means must be provided for removing or neutralizing undesirable gases or vapors originating in the furnace during the annealing operation. Lastly, the furnace must be designed to prevent infiltration of foreign gases or vapors from outside the furnace.

★ ★ ★

THE selection of a suitable protective atmosphere begins with a knowledge of the analysis of the metal or alloy, the maximum temperature of heat-treatment, the time at temperature, cooling requirements and surface condition of the work going to the furnace. The latter refers specifically to the type or quantity of oil or drawing compounds, oxidation products or other foreign materials which may have an effect upon the atmosphere or on the final surface appearance of the wire.

★ ★ ★

IT is quite common knowledge that free oxygen is undesirable in any atmosphere used in conjunction with clean or bright annealing of non-ferrous wire. Therefore it can be assumed that air must be eliminated from the annealing furnace. Oxygen or air must be kept out of contact with the wire during cooling if discoloration is to be prevented.

★ ★ ★

HYDROGEN sulphide is also generally objectionable because of its affinity for non-ferrous metals. Sulphides of the metals once formed are of a distinctive color and are particularly difficult to remove.

★ ★ ★

UNLESS chemically pure tank gases or their products such as hydrogen, nitrogen or dissociated ammonia are used as they are in some non-ferrous annealing operations, the problem of oxygen and hydrogen sulphide removal must be of primary consideration. Since all protective atmospheres other than the above are the products of combustion of air-fuel gas or air-dissociated ammonia mixtures, the possibility of oxygen or hydrogen sulphide contamination cannot be emphasized too strongly.

★ ★ ★

WHEN air-fuel gas mixtures are burned so as to eliminate all free oxygen, the resulting products are carbon dioxide, water vapor and nitrogen with controllable small amounts of carbon monoxide, hydrogen and methane if desired. The dissociation of ammonia brought about by heating gaseous anhydrous ammonia, produces a mixture containing approximately 75% hydrogen and 25% nitrogen and an infinitesimally small amount of water vapor. If the dissociated ammonia is then mixed with air and burned, the nitrogen remains but some or all of the hydrogen combines with oxygen to form water vapor. By correctly proportioning the amount of air used variable mixtures of hydrogen, water vapor and nitrogen will be obtained. It is by proper control of the amounts of the above constituents formed by combustion as well as supplemental removal of one or more of these constituents, as for example carbon dioxide or water vapor, that truly protective atmospheres are possible for most types of non-ferrous alloys.

★ ★ ★

Copper and Nickel

COPPER, nickel and a few of their more simple alloys are by far the easiest non-ferrous materials to bright anneal. Actually these metals are not oxidized by water vapor or carbon dioxide, both of which are usually considered to be oxidizing gases. Perhaps the first protective atmosphere used was steam for clean annealing copper wire and other products in batch type furnaces. Even today, steam is frequently

used during heating up cycles in batch furnaces and as makeup atmosphere in continuous type copper and copper alloy annealing furnaces.

★ ★ ★

FOR the production of truly bright annealed copper wire, it is not sufficient to use only neutral constituents such as water vapor, carbon dioxide and nitrogen. Even the slightest trace of oxygen in the atmosphere will discolor the copper under such conditions. Also any discoloration or superficial oxidation on the copper before entering the annealing furnace will mar the appearance of the finished product. Foreign materials such as oil or drawing compounds on the wire may produce oxidizing constituents in the heating furnace to subsequently attack the copper or such lubricants may carbonize during the heating process and leave a black smudge on the surface of the metal which is almost impossible to remove.

★ ★ ★

PARTICULARLY with regard to copper and nickel, too much emphasis cannot be laid on the desirability of eliminating sulphur as an ingredient of drawing compounds and lubricants. Even such light lubricants as kerosene, which readily volatilize under heat without leaving smudge on the work, may contain sufficient sulphur so as to require a very large flow of protective atmosphere sweeping over the work to prevent surface attack by the sulphides liberated from the lubricant. In order to insure brightness of the annealed copper wire, it is necessary to maintain small but sufficient amounts of reducing gases in the furnace atmosphere. These reducing gases will be carbon monoxide and hydrogen. Their presence assures not only the complete elimination of all free oxygen during combustion of a suitable air-gas mixture in an atmosphere generator or in a direct fired bright annealing furnace but also counterbalances traces of free oxygen which may enter the furnace. Furthermore, they reduce any oxides originally on the surface of the work.

★ ★ ★

THE required percentage of reducing constituents is largely dependent upon the metal to be annealed. Copper and nickel are bright annealed in atmospheres containing as little as 1.5% of reducing gases Such so-called "lean" atmospheres prevent absorption of hydrogen from the hot atmosphere —"hydrogen embrittlement" of electrolytic copper — and also eliminate staining of the work by traces of hydrogen sulphide. Many raw fuel gases, particularly coke oven gas, contain more or less sulphur compounds. By adjusting the air-fuel gas ratio to provide a slight deficiency of air, most of the sulphur is oxidized during combustion to sulphur dioxide which is inert to copper and nickel. If desired, the sulphur dioxide can be removed by washing in cold water sprayed over limestone. The gas may be still further purified to remove remaining traces of hydrogen sulphide by passing through an iron oxide-shavings tower. If the air-fuel gas ratio was adjusted to provide appreciably higher percentages of hydrogen, excessive amounts of hydrogen sulphide would remain in the finished gas.

★ ★ ★

ORDINARILY protective atmosphere annealing implies a furnace with a heating chamber and a cooling chamber in which the work is surrounded by and in contact with gases of a fixed composition. According to this generally accepted description, it is to be expected that the heating gases and the protective gases are separated either by means of a muffle or by burning the heating gases in radiant tubes. However, if the heating gases after combustion, reach a composition suitable for the desired protection of the work, a direct fired furnace becomes both a heat-treating furnace and a protective atmosphere generator. This is often times true in the annealing of copper or nickel wire. It is only necessary to set the air-gas heating mixture slightly on the reducing side to safeguard against the presence of harmful free oxygen in the products of combustion.

★ ★ ★

PRESENT day air-gas proportioning devices are of sufficient accuracy to insure a constant flue gas analysis over the entire range of burner capacities and turndown. Thus, the same composition of the gases within the furnace chamber can be maintained regardless of the rate of firing.

★ ★ ★

OBVIOUSLY a direct fired furnace is most economical in operating cost and low in initial capital investment. The most elementary form of such self-generating protective atmosphere furnace is one in which several burners of small capacity are arranged to fire above and below the work and from both sides.

★ ★ ★

MOST modern adaptation of direct fired bright annealing furnaces provides one or more

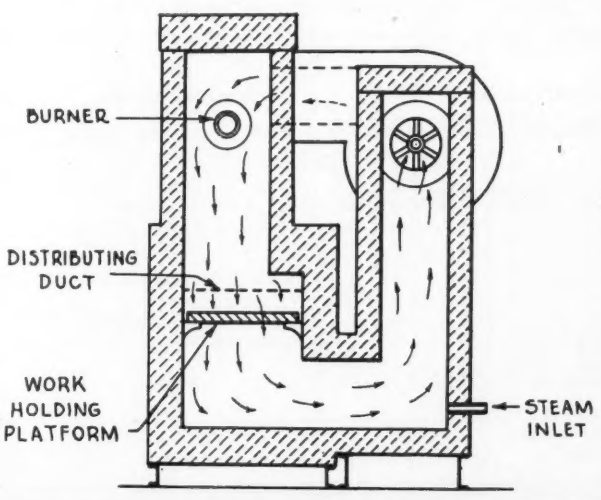

Figure I—Convection heating annealing furnace with recirculated flue gas-steam atmosphere. (In crossection)

combustion chambers placed outside the work-heating chamber and in the path of an external fan which recirculates large volumes of hot gases through the furnace. This "convection heating" is particularly well suited for copper wire and several other non-ferrous wires because of their comparatively low annealing temperatures. Convection heating is much more efficient at low temperature than is radiation heating. A convection heating furnace embodying the feature of using recirculated heating gases for protective atmosphere in copper wire annealing is shown in cross section in Figure 1. The products of combustion from the burner mixed with recirculating atmosphere from the fan pass down over the work and are returned to the fan through the insulated duct at the right. It goes without saying that gas tight furnace construction is necessary to prevent contamination of the protective atmosphere by air infiltration. Opening for work introduction and discharge must be suitable to prevent such infiltration.

★ ★ ★

A CONSTANT minimum flow of protective atmosphere must be supplied to maintain a slight positive pressure in any furnace. In the convection type shown in Figure 1, the supply of protective atmosphere may be kept constant by firing the burner at a steady rate or within a safe range of turndown and providing a cooling coil in the return duct through which a portion of the gases can be bypassed by a damper operated by the temperature control of the work heating chamber. This permits a constant air-gas input at the burner and the rate at which the atmosphere flows into the furnace is maintained constant without sacrificing accuracy and uniformity of temperature control. Another method for maintaining the necessary positive pressure of atmosphere within the furnace regardless of the output of the burner is to provide steam make-up. As shown in Figure 1, this steam may be introduced in sufficient quantities in the return duct to the fan. The amount of make-up steam can be controlled by furnace pressure, burner output or other suitable means.

★ ★ ★

IN continuous copper annealing furnaces employing burners directly in the heating chamber, steam or additional atmosphere from a generator can be most advantageously employed. The make-up steam or generator gas is usually added near the entrance and exit openings to insure most effective utilization. Heating rates approaching those obtained in convection furnaces can be reached by installing fans directly in the heating chamber.

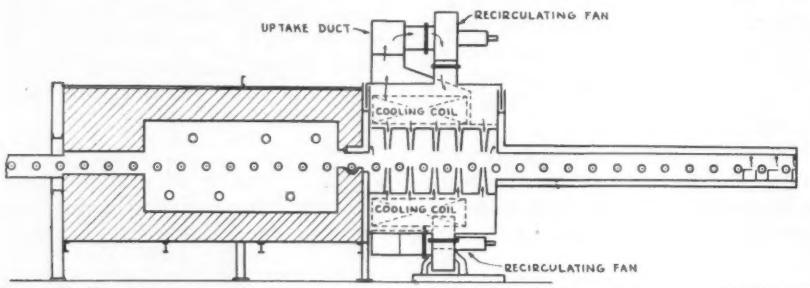

Figure II—Direct-fired annealing furnace showing accelerated cooling and flue gas dehydrating zone between heating and slow cooling sections.

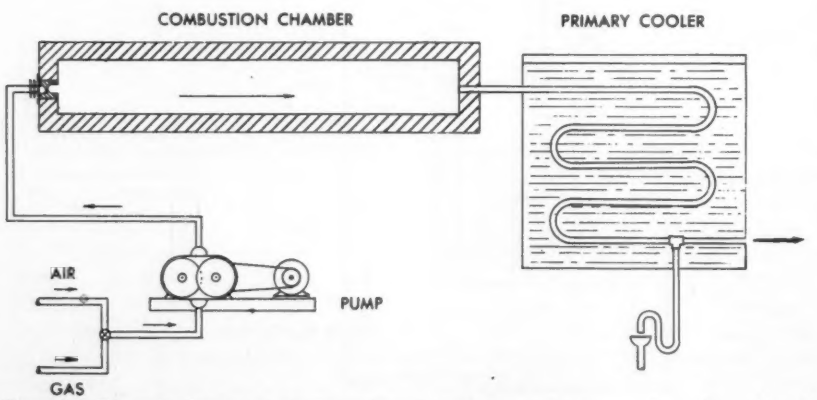

Figure III—Schematic diagram of simple exothermal atmosphere generator.

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IN any discussion of protective atmosphere applications to continuous annealing furnaces, it should not be amiss to mention the necessity for careful selection of seals for work openings. Flame screens, asbestos, or chain curtains, heat seals and manually or automatically operated doors are most commonly employed. The choice is governed by the type of work conveyor, by the cycle of furnace operation, by the height of the charge and discharge openings and by the size and shape of the work itself. Where the work can be quenched, a water curtain makes a very effective seal for the discharge end. From the above it appears that non-ferrous wire in the copper and nickel classifications present no complicated atmosphere problems for protection during annealing. Furnace generated atmosphere with or without steam additions will produce and maintain clean and bright work in the furnace. There is an additional step after heating to annealing temperatures. It is then necessary to cool the wire without reoxidation or other discoloration. Reoxidation will occur if bright annealed wire contacts air before being cooled to a temperature of below about 200° F. Other discoloration may result from hydrogen sulphide attack during cooling or it may be due to moisture or oil collecting on the metal surfaces at relatively low cooling temperatures. Naturally any of these effects during cooling will defeat the purpose for protective atmosphere annealing.

★ ★ ★

ATMOSPHERE control during cooling becomes just as important as the control during heat-

ing. If copper and nickel wires are annealed in strand form, they may be water quenched directly from the heating chamber, thus eliminating cooling zone problems. Such wires will be clean and bright as they leave the water quench. If provisions are made to dry the wire quickly, no water staining will occur. Usually the quench water is maintained at a high temperature between 150° F. and 200° F. so that moisture will evaporate rapidly from the warm wires.

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WHEN copper or nickel coils are being annealed, water quenching results in staining because of the liquid working in between the wraps of the coils. All such work requiring a high quality of surface brightness must be cooled in a comparatively dry protective atmosphere. This considerably increases the cooling time and necessitates long cooling zones, although judicious use of fans for recirculation can materially shorten these zones. In direct fired furnaces, the high water vapor content in the heating zone atmosphere may be reduced to the necessary low percentage for cooling zone use by drying the gases in a gas recirculating section provided with a cooling coil and inserted between the heating and the cooling zone chambers. Figure 2 shows such an arrangement.

★ ★ ★

THE elimination of moisture condensation problems when cooling zones are involved is most practically obtained by employing indirect fired furnaces. Such furnaces are provided with muffles to separate the work from the heating chamber proper or employ heat radiating elements which eliminate any gaseous products of combustion from the work heating chamber. The protective atmosphere for the heating and cooling zones of such furnaces is provided by an independent generator in which the moisture as well as the other constituents of the atmosphere can be accurately controlled.

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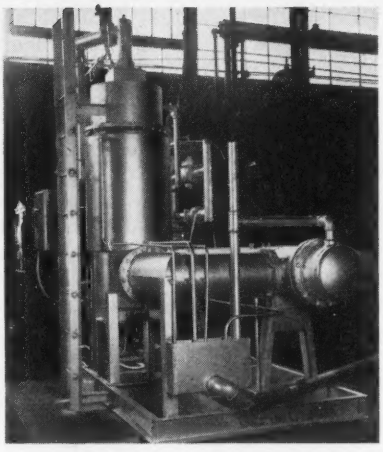

Figure IV—Typical exothermal gas generator.

ALMOST simple type of atmosphere generator is satisfactory for clean or bright annealing and cooling of copper or nickel wire in any form. Figure 3 shows a schematic arrangement of the most commonly used type of protective atmosphere generator for copper and nickel.

★ ★ ★

AS previously explained the primary requirements are to exclude oxygen and hydrogen sulphide and to provide approximately 1.5% of the reducing gases, hydrogen and carbon monoxide for scavenging purposes. If correct proportions of air and fuel gas are mixed and burned in the combustion chamber of the generator and the products of this combustion are passed through a primary cooler as shown in Figure 3, the atmosphere produced can be maintained with substantially the following analysis when using natural gas as the fuel:

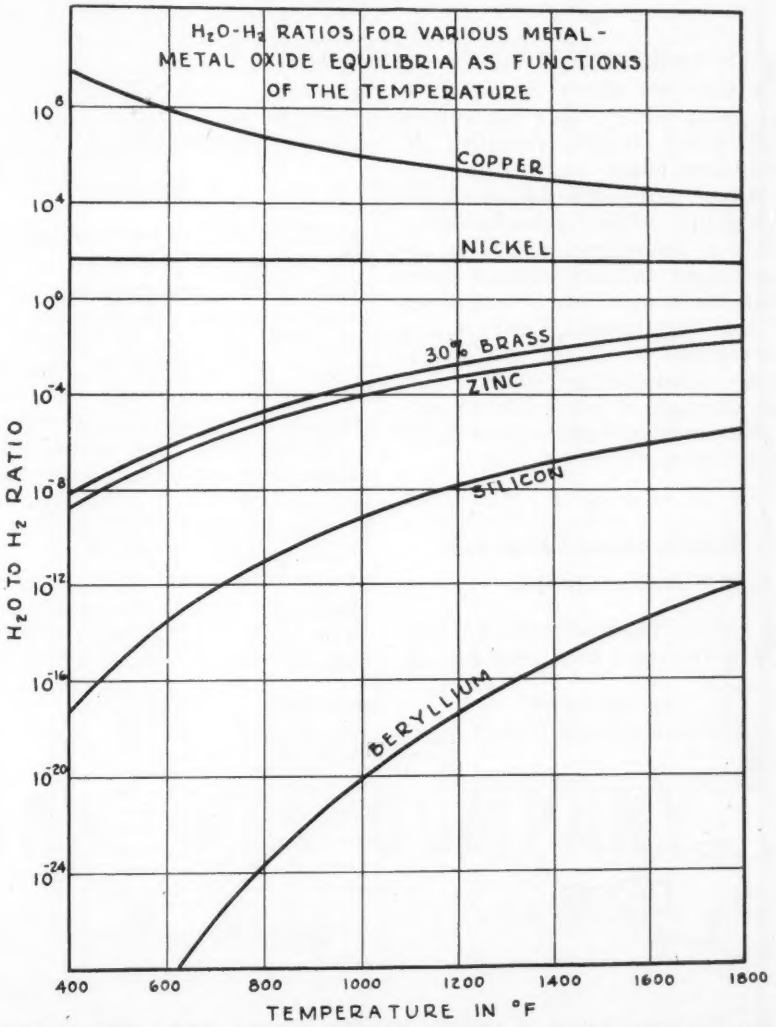

Figure V—H_2O — H_2 Ratios for various metal-metal oxide equilibria as functions of the temperatures.

H_2 — 0.8%
CH_4 — 0.0%
N_2 — 88.0%
CO_2 — 10.5%
O_2 — 0.0%
CO — 0.7%

★ ★ ★

THE moisture content of the above gas will be reduced from approximately 18% as it leaves the combustion chamber to a relatively small amount corresponding to a dew point just a little higher than the temperature of the cooling water in the primary coolers. Since the dew point will thus be less than 100° F., it will be appreciated that no moisture condensation problems will be encountered in cooling copper or nickel wire to temperatures of about 150° F., providing all portions of the cooling zone are maintained slightly above 100%.

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ATMOSPHERE generators of the type shown in Figure 3 are most widely used for copper and nickel bright annealing in both continuous and batch type furnaces. Although not shown in the figure, sulphur removal equipment is sometimes added where fuel gases initially contain more than minimum allowable quantities of this constituent. Figure 4 is a photograph of one of the several types of similar generators used for atmosphere production in connection with bright annealing of non-ferrous wires.

★ ★ ★

Brasses, Nickel-Silvers and Precious Metals

AS annealing treatments particularly bright annealing, are applied to non-ferrous metals other than copper or nickel, the problem of protective atmospheres usually becomes increasingly difficult. True, gold, fine silver and other precious metals like palladium are as easily handled as copper or nickel. However, there are a large number of applications in which these metals as well as copper and nickel are heat-treated in alloyed form. Alloying elements are added for well established reasons and usually involve addition of zinc, silicon or beryllium alone or in combination and in widely varying amounts. These last three elements when heated, oxidize readily in air and are also oxidized by hot carbon dioxide and water vapor. Therefore, theoretically suitable atmospheres for bright heat-treatment of alloys of these elements must exclude oxygen in free and combined form. This means the use of a pure inert gas as nitrogen, an actively reducing gas such as hydrogen or a combination of the two as dissociated ammonia or partially combusted and dehydrated ammonia.

★ ★ ★

ACTUALLY, the commercial production of protective atmospheres for heat-treating such readily oxidized alloy wires has been the subject of widespread interest and of intensive research. The problems involved apply not only to the tons of copper-zinc, copper-beryllium and copper-zinc-silicon alloys produced in the copper and brass wire industries but as well to smaller quantities but more valuable products of the precious metal field. In these latter plants, red, yellow, pink, green and white golds are produced and these may contain as high as 18% zinc in combination with a gold base. Again semi-precious metals such as nickel-silver are alloys which contain a large portion of copper and nickel but also contain zinc in quantities as high as 25 to 30% of the total weight.

★ ★ ★

UNQUESTIONABLY it is difficult to visualize the extent to which even traces of oxygen bearing gases will affect the surfaces of these sensitive alloys. It might be helpful to graphically illustrate the effect of only one of these oxidizing gases upon some of the metals and alloys in question. Figure 5 is a chart showing the maximum ratios of water vapor to hydrogen which are allowable to prevent oxidation of several non-ferrous materials within the normal heating and cooling ranges. The infinitesimally small amounts of water vapor permissible with beryllium and silicon and the only slightly larger amounts allowable with pure zinc and 30% brass is quite disturbing. The nickel-silvers and zinc bearing gold alloys are only slightly less susceptible to water vapor. It is not difficult to see how necessary is the preparation of bone dry protective atmospheres for bright or clean annealing these metals.

★ ★ ★

IN general carbon dioxide behaves very similarly to water vapor. As with the water vapor-hydrogen combination, it is the carbon dioxide-carbon monoxide ratio rather than the carbon dioxide percentage alone which determines the concentration permissible for bright annealing. Its action on non-ferrous metals is less severe than that of water vapor. Nevertheless, its presence is a warning signal since it combines with hydrogen to produce water vapor in the furnace chamber according to the chemical reaction:

$$CO_2 + H_2 = CO + H_2O$$

★ ★ ★

THE equilibrium between the four constituents results in an increase in water vapor in an initially dry atmosphere within a hot

(*Please turn to page 976*)

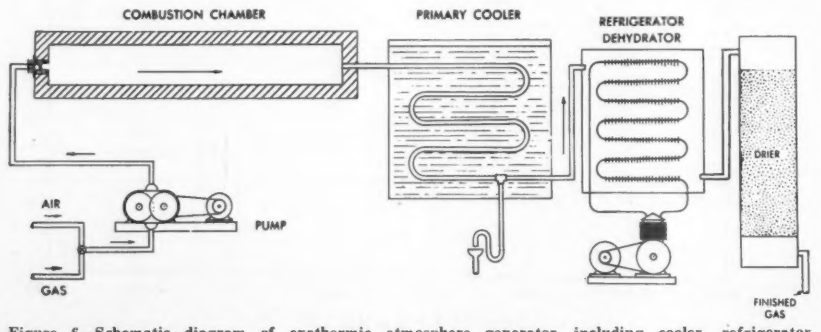

Figure 6—Schematic diagram of exothermic atmosphere generator including cooler, refrigerator, and drier.

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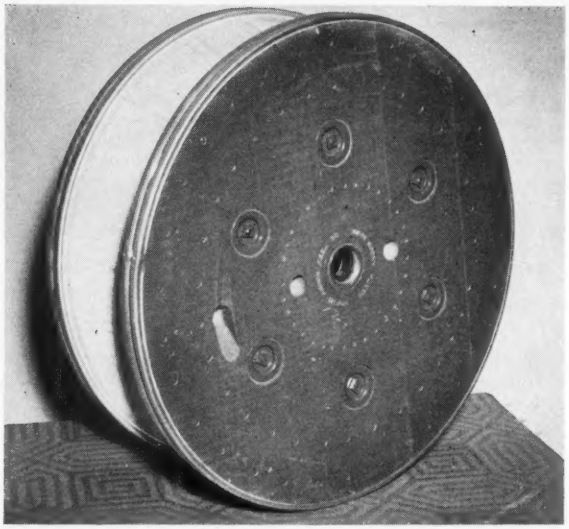

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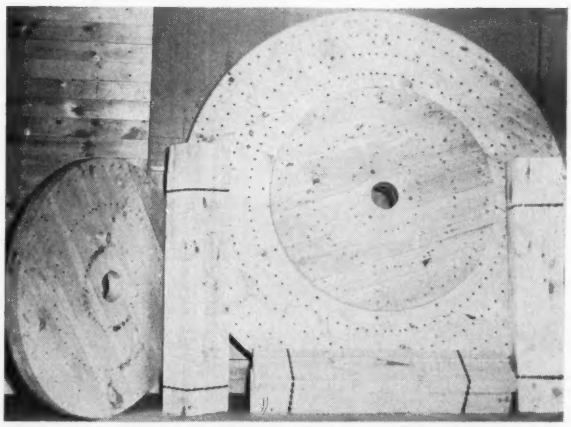

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Welding in the Wire Industry

By John H. Corson

Head of Metallurgical Section, Development Engineering Department,
John A. Roebling's Sons Company,
Trenton, N. J.

The author describes experiments to make welds of a quality high enough to be left in the finished wire. The conclusions reached were that both methods tried were unsatisfactory; the problem is yet to be solved and may lay in resistance butt welding.

WELDING is as closely associated with modern wire drawing as is the tungsten carbide die. Without welding, continuous high speed machine drawing would be useless. Considering its importance, little has been done to control and improve it. In the past few years the wire industry has become more conscious of welding and its relative importance because of restrictive specifications regarding welds in drawn wire.

★ ★ ★

THE first published discussion of welding in the wire industry, to the writer's knowledge, was **"Welding for Wire Drawing"** by **J. Hutchinson** in the April 1949 issue of Wire and Wire Products, in which the factors and principles of resistance butt welding were ably presented. Although the paper concerns aluminum and its alloys, the principals apply to copper and steel as well.

★ ★ ★

THIS paper is mainly concerned with the quality of welds in relation to the specifications for the wire. In order to obtain help as well as a broader perspective for the writing of this paper, a number of wire producers and wire consumers were asked their opinions on welding and weld quality. The following paragraphs summarize their answers.

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LOW carbon steel, commercially pure aluminum and copper, and austenitic alloy steels can be welded and the welds will wire draw the required amounts without difficulty. The welds generally are acceptable in the product.

★ ★ ★

HIGH carbon steel can be welded and the weld successfully wire drawn. However, several stated that there was no absolute assurance that welds in high carbon steel would accept the required wire drawing. The quality of wire drawn welds in high carbon steel was very much open to question, and acceptance depended primarily upon the products involved. In many instances the welds are cut out. Difficulty occurred in welding finished rope wire to make continuous lengths. A need was expressed for a completely automatic welder.

★ ★ ★

THE hardenable stainless alloy steels[1] are difficult to weld and as yet no satisfactory method has been found.

JOHN H. CORSON

Born September 12, 1920 in Oakmont, Pennsylvania. Attended schools in Oakmont, Pennsylvania and Shady Side Academy. Graduated from Lehigh University in 1943 with a B.S. in Metallurgical Engineering. Was a member of the Armed Forces for two and one-half years. Since December 1945, has been associated with the Development Engineering Department of John A. Roebling's Sons Company.

★ ★ ★

ALUMINUM alloys can be welded satisfactorily. Difficulty has been encountered in wire drawing welds in 56-S. The welds are left in aluminum alloy wire products unless specifications require them to be cut out.

★ ★ ★

COPPER alloys can be welded successfully with the exception of some of the high tin content bronzes and high lead content brasses. Sometimes variations in rod end hardnesses and in chemical analyses present difficulties. The welds are left in the product unless specifications require them to be cut out. Proper operation of the welder was specified as a prime necessity.

★ ★ ★

QUITE obviously there are a number of problems which need a solution. Acceptance of the weld in the drawn wire is the main one and appears most general in the field of high carbon steel. In this paper the writer will discuss experiments which have been carried out by **John A. Roebling's Sons Company** in an effort to solve this problem. Also a solution will be presented to the problem of weld failures in spooled rope wire.

★ ★ ★

THE problem of the wire drawn weld, centers around its physical properties. The ultimate tensile strength of such a hard drawn weld will generally be at least 90% of the parent material, so that this physical property is fairly satisfactory. However, the ductility of that weld, as measured by the bend test, and more par-

(1) Alloy Metal Wire Co., Inc.

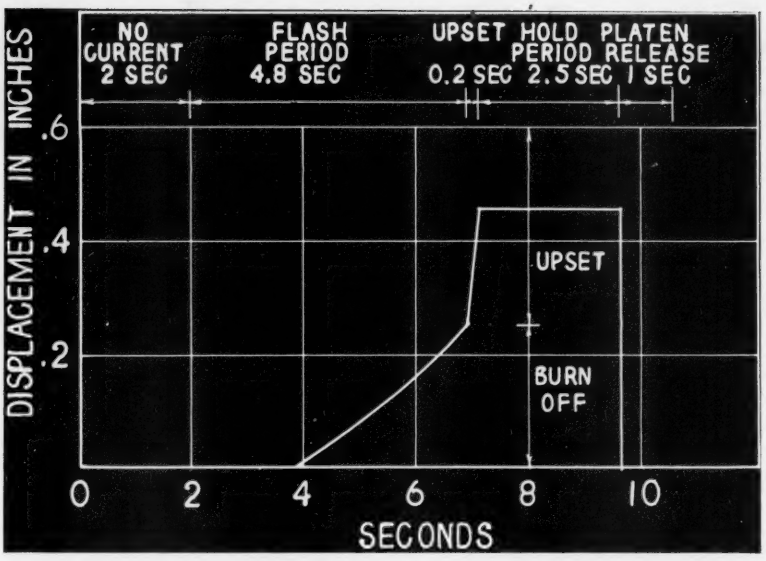

Fig. 1—Cam characteristics of Micro Products' Flash Welder, Model MDF, 440 V, 50 A, 60 Cycle, Capacity .250-.500" Dia.

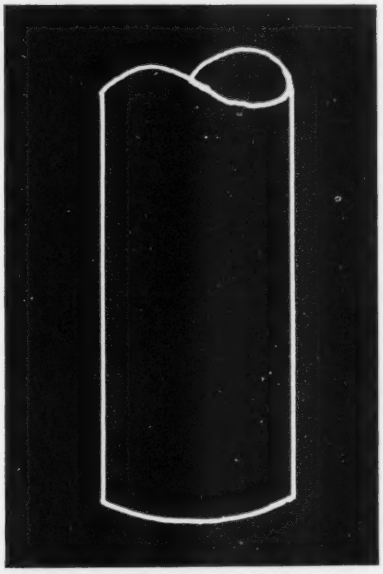

Fig. 2—Diagrammatic view of beveled rod end preparation.

ticularly the wrap test, is not satisfactory. An experimental program has been carried out in an attempt to make a weld which, after wire drawing, would accept wrap testing. The following describes two types of welding which were tried in an effort to solve the problem.

★ ★ ★

THE first program was to make good flash butt welds on .80% carbon steel hot rolled rod which would be heat treated to the required strength, wire drawn, and then wrap tested.

★ ★ ★

BY a good weld we mean one which satisfied the following requirements:

1. **Good fusion**
2. **Free from decarburization**
3. **No as-cast structure**
4. **No martensite formation on cooling from welding temperature.**

★ ★ ★

THE experimental work was carried out on a Micro Flash Welder, (Model MDF, 440 volts, 50 amperes, capacity .250/.500 diameter rod). The characteristics of the flash welder are shown in Fig. 1. The welder had eighteen settings which had an open circuit secondary voltage range of 2.7 to 5.9 volts. The rod ends were prepared with a bevel, as shown in Fig. 2. The rod ends, where they were in contact with the electrodes, were cleaned with a power driven wire brush.

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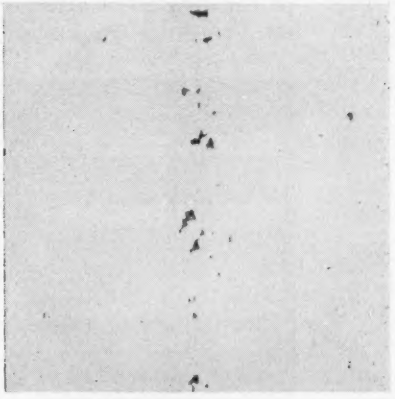

Fig. 3—Included oxide in weld line of .360" diameter rod. 500X.

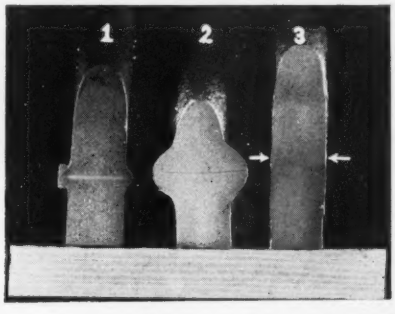

Fig. 4—Effect of hot upsetting and subsequent forging on diffusion of weld zone decarburization.

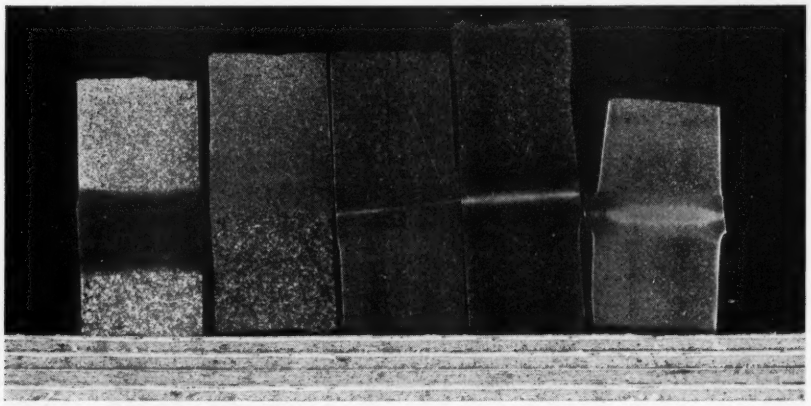

Fig. 5—Effect of current cut-off time during upsetting on decarburization.

WELDS were made on each of the eighteen settings to determine the optimum setting by the appearance of the metal pushed out at the weld. The six settings in the middle of the range resulted in extrusion of metal sufficient in amount and uniform

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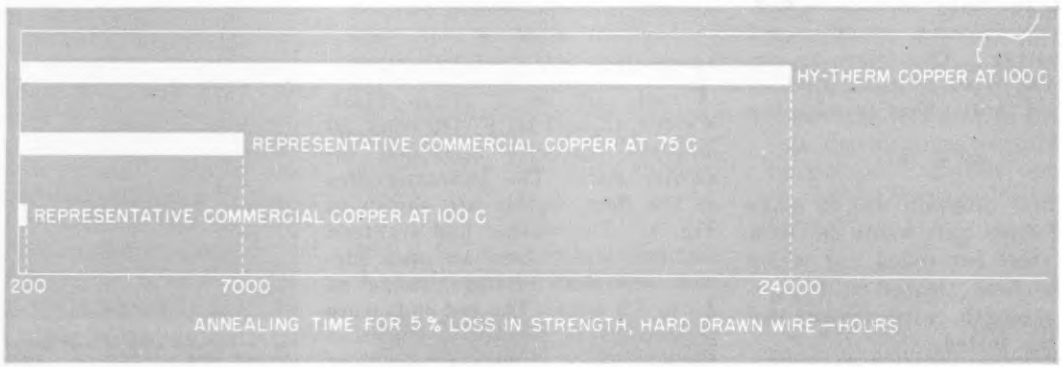
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REPRESENTATIVE COMMERCIAL COPPER AT 75 C
REPRESENTATIVE COMMERCIAL COPPER AT 100 C
200
7000
24000
ANNEALING TIME FOR 5 % LOSS IN STRENGTH, HARD DRAWN WIRE—HOURS

CONDUCTIVITY:

This new brand of copper is produced by adding minute amounts of hardening agents to very pure electrolytic copper. Due to its controlled composition, it has consistently uniform properties. The types and amounts of added material are so chosen that their effect on purity and conductivity are negligible.

	Hy-Therm Typical Values	ASTM B 5-43 Specified Minimum
Copper (including silver), %	99.953	99.900
Conductivity at 20 C, % IACS	100.9	100.0

*An Anaconda Trade-Mark

ANACONDA from mine to consumer

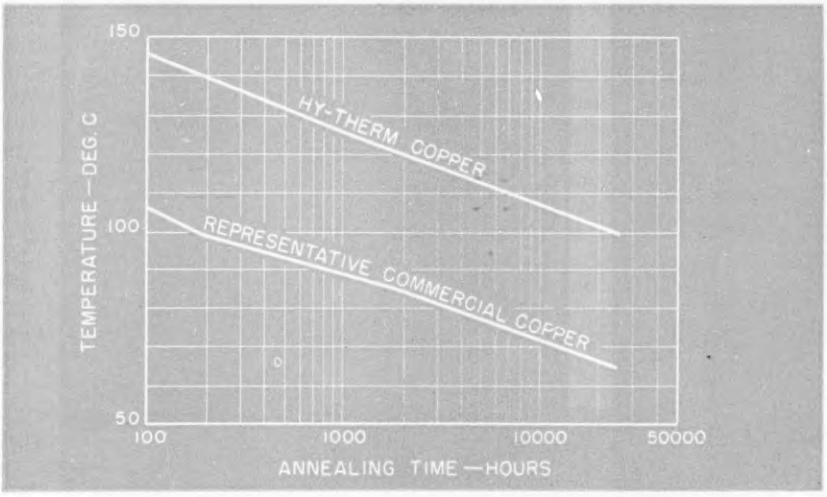
ANACONDA WIRE &

Subsidiary of Anaconda Copper Mining Company

Hy-Therm* Copper

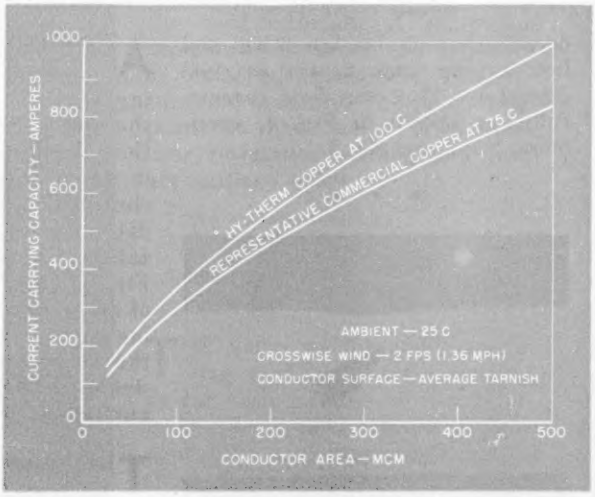
NEW

CURRENT-CARRYING CAPACITY:



On an equivalent annealing basis, tests show that Hy-Therm copper can withstand a continuous operating temperature 35 C higher than that for representative commercial copper.

Accepting that maximum operating temperatures of 75-80 C have been satisfactory in the past, Hy-Therm copper could be rated at 110-115 C. However, since it is probable that future lines will be designed to closer operating limits than formerly, a more conservative value of 100 C has been selected for current-carrying capacity calculation. On this basis, Hy-Therm copper will carry approximately 20% greater current.



*BRAND AHT (ANACONDA HY-THERM)

CABLE COMPANY

25 Broadway, New York 4, N.Y.

around the periphery. Metallographic examination of the welds showed these six settings to be free from included oxide but to contain considerable decarburization. One setting in the middle of the six was arbitrarily chosen for all future work. Consistency tests for soundness of welds and decarburization indicated that some of the welds (20-40%) contained small amounts of oxide in the weld line. See Fig. 3. Decarburization was present as is shown in Fig. 4, specimen No. 1. At this time the included oxide was overlooked and attention focused on diffusing the decarburization by upsetting and hot forging back to the original diameter. This was done successfully, as shown in Fig. 4, specimens No. 2 and No. 3.

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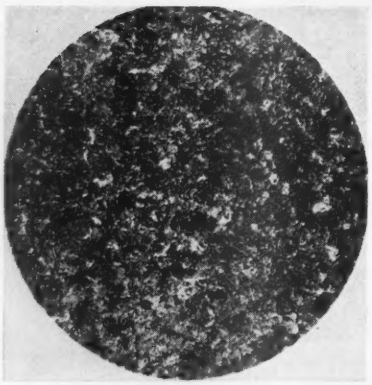

Fig. 6—Photomicrograph of weld made with current shutting off at commencement of upset.

A RE-EXAMINATION of the welder showed that the welding current was shutting off at the mid-point of the upsetting action. Additional welds were made in which the welding current was shut off after varying intervals to determine the effect on decarburization. The results are shown in Fig. 5. The white line is evidence of decarburization. When the flashing current was shut off exactly at the commencement of the upset, a weld was made free from decarburization, as shown in Fig. 6.

★ ★ ★

THE microstructures of flash welds did not show any typical as-cast structure as is normally seen in resistance butt welds, but to make sure it was eliminated, welds were hot worked by upsetting on the welder and forging back with an air hammer to the original diameter.

★ ★ ★

ELECTRICAL arrangements were made so that the weld could be cooled slowly to prevent the formation of martensite. However, it was found that the cooling without benefit of electrical arrangements was at a slow enough rate to insure a pearlitic structure.

★ ★ ★

A STRING of welds was then heat treated, wire drawn and tested. Forty-three welds were made, hot upset and forged back, also forty-two welds were made, not upset and forged back, but merely had the flash ground off. Fig. 7 shows typical views of the two types of welds. Fig. 8 shows

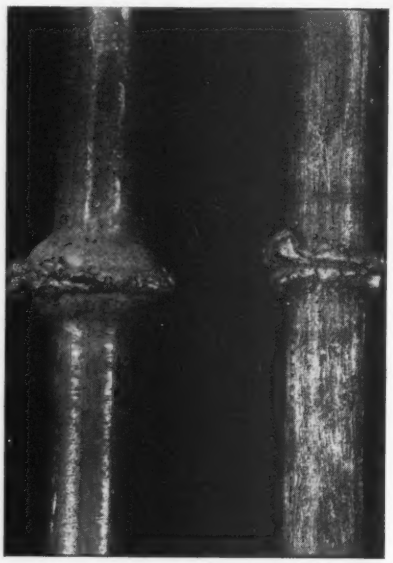

Fig. 7—View of welded rod, as welded and hot upset.

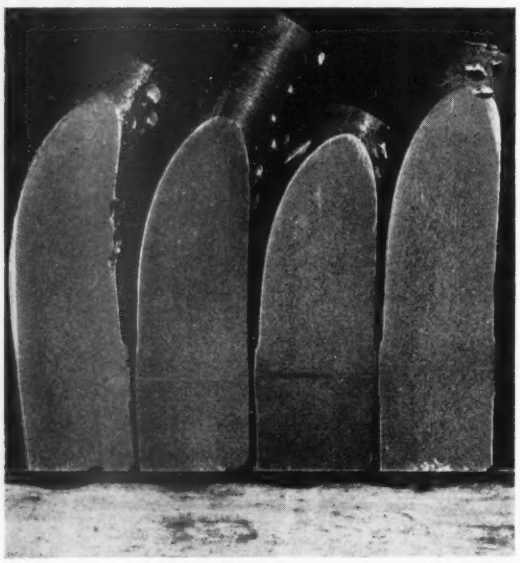

Fig. 8—Spot metallographic tests for uniformity and freedom from decarburization.

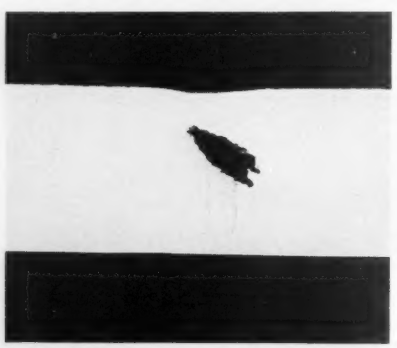

Fig. 9—Internal void at weld indicated by surface depression. Oxide present at ends of void.

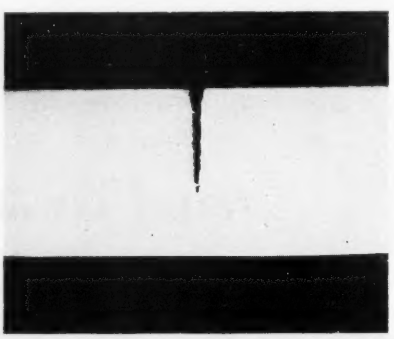

Fig. 10—Surface crack in weld with oxide at base of crack.

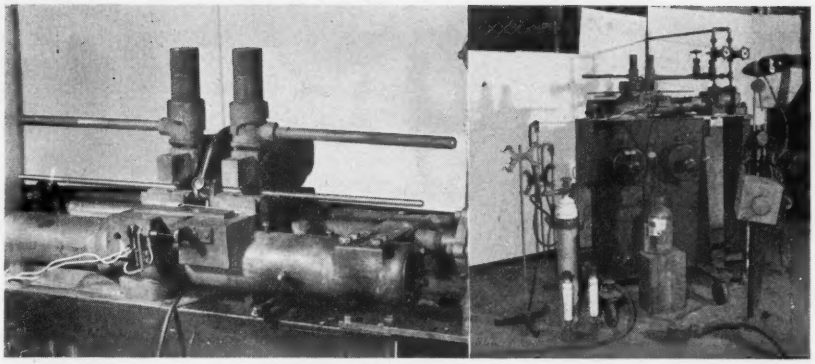

Fig. 11—Pressure welding set-up with gas train, welder and hydraulic cylinder.

spot metallographic tests for uniformity and freedom from decarburization. At 1000X the only evidence of a weld was a transverse line of very fine pearlitic grains. The surface of the welds was prepared by polishing with a 2/0 emery paper in the longitudinal direction to eradicate any cross scratches left from the coarser emery papers, thereby any considerations of poor surface would be eliminated.

★ ★ ★

THE welds were lead patented and wire drawn 4 holes. In the wire drawing, 12 out of 43 welds which had been upset and forged back broke in the die, and 5 out of 42 welds which were not upset and forged back also broke in the die.

★ ★ ★

THE weld surfaces were examined for defects. Two types of defects were noted. One was a surface rupture and the other was a sucking of the surface at the weld. Metallographic sections taken through a number of such defects showed that included oxide previously overlooked was the cause of the defects. Figs. 9 and 10 show the two types of defects. The remaining good wire was galvanized and physically tested.

★ ★ ★

THE tensile strength of 5 welds in both groups was (with one exception) at least 90% of the strength of the stock wire. The elongation and reduction of area values of those samples which failed in the weld during the tensile test were low. These results could also be associated with the surface imperfections. Hot upsetting and forging back did not improve the elongation and reduction of area values as was hoped.

★ ★ ★

SEVEN welds which had been hot upset and forged back were wrap tested. Although none of the 7 had any surface defects, 6 of them would not wrap around twice their diameter. In wrap testing 12 welds made without hot forging, 6 accepted the wrap test. Of those which failed, 4 showed no surface defects and of those which accepted wrapping, 4 showed surface imperfections. Failure or success in wrap testing samples which contain surface defects appears to depend upon the location of the defect in relation to the mandrel.

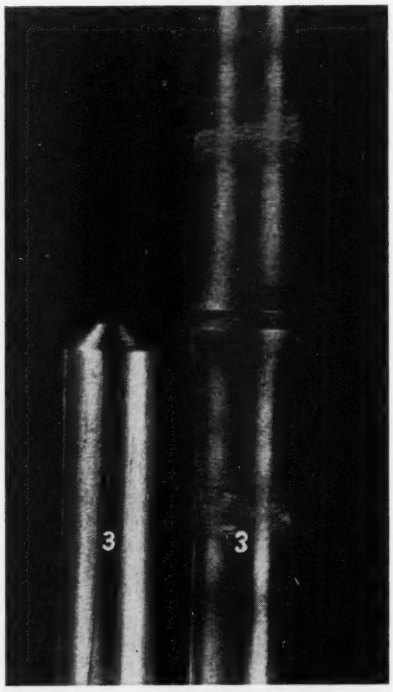

Fig. 13—View of beveled end and resultant upset after welding.

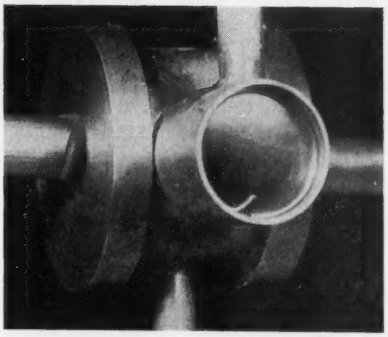

Fig. 12—View of air tight gas chamber.

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THESE welds failed to accept wrapping because of the surface and sub-surface defects. The included oxide which caused these defects is inherent to the flash welding process. Therefore it was concluded that flash welding would not result in welds which would accept the wrap test. Work on flash welding was then discontinued and attention turned to solid phase pressure welding.

★ ★ ★

SOLID phase pressure welding differs from regular resistance welding in that the weld is made not at liquid or fusion temperatures but by atomic bending across the weld interface at sub-fusion temperatures under the influence of controlled atmosphere, temperature and pressure. The process appears to have some advantages over resistance welding and they are outlined below:

1. No as-cast structure
2. No overheating or burning of the steel
3. No included oxide.

★ ★ ★

THE same welder and material was used for pressure welding as for flash welding with the following exceptions: pressure was applied by a hydraulic cylinder instead of by a motor driven cam; the voltage was reduced from 440 to 220 volts. A picture of the set-up is shown in Fig. 11.

★ ★ ★

THE welds were made in a neutral or reducing atmosphere. An airtight gas chamber, shown in Fig. 12, was used. A glass window permitted temperature measurement by an optical pyrometer. Two vertical tubes provided inlet and outlet for the gases. The two caps on either side were removable by unscrewing. Rubber discs were placed between the caps and the body of the chamber. The discs had a hole smaller than the rod so that they would grip the rod and form a gastight seal. Silicone rubber, which decomposes thermally above 600° F., was used for the discs.

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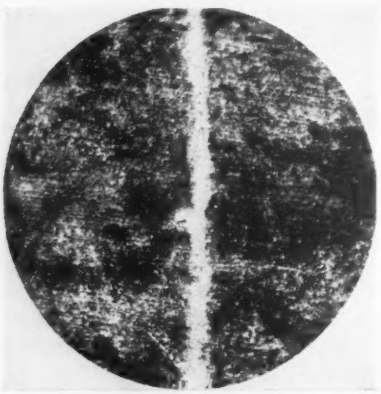

Fig. 15—Photomicrograph of pressure weld made in H_2 with blued rod ends—alkaline chromate etch. * * * * *

A GAS train was employed between the tank and the chamber to remove any residual amounts of oxygen, water and carbon dioxide. An oxygen absorber, pyrogallic acid, ascarite and asorbite were used to accomplish the removal of these gases. The chamber was purged before making a weld. Welds were made either with square or beveled rod ends, as shown in Fig. 13. After welding, the upsets were forged back or ground off, followed by heat treatment, wire drawing and testing.

★ ★ ★

INITIAL work in determining the proper welding conditions indicated that a temperature of 2100° F., a platen movement of ¼" and a pressure of 11,750 p.s.i. on the rods were satisfactory. The temperature was first controlled with an optical pyrometer but was later more accurately and uniformly

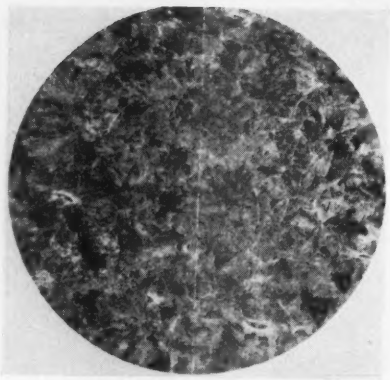

Fig. 14—Photomicrograph of pressure weld made in hydrogen and etched in an alkaline chromate etch. * * * * *

controlled with a limit switch. The platen movement was controlled by a stop adjusted to ¼" of movement. The platen movement was sufficient for square and beveled end preparation.

★ ★ ★

THE first welds were made in a hydrogen atmosphere. Metallographic examination of polished sections showed the welds to be clean and sound. Examination of nital-etched samples failed to reveal any weld line whatsoever. However, when the sample was etched in an alkaline chromate etch, a white line appeared, which indicated a weld line, as shown in Fig. 14. Note the grain growth across the weld line. This line was believed to be an oxide line and had been observed by other investigators.

★ ★ ★

A QUICK test verified this thought. The ends of two rods were heated in a furnace until a blue oxide was present on the surface. These two ends were then welded together, examined metallographically with the alkaline chromate etch and the results are shown in Fig. 15. The line here is broader but otherwise similar to that in Fig. 14. This test appeared to indicate that the white line was due to oxide.

★ ★ ★

THE next step was to trace the source of the oxygen or oxide. The first check was on the hydrogen itself, and the following gas analysis was made using an Orsat Gas Analyzer:

	O_2	CO_2	CO
H_2 from tank	0.2%	0.2%	0.0%
H_2 from tank through train and chamber	0.0%	0.0%	0.0%

The hydrogen in the chamber was apparently free from oxygen.

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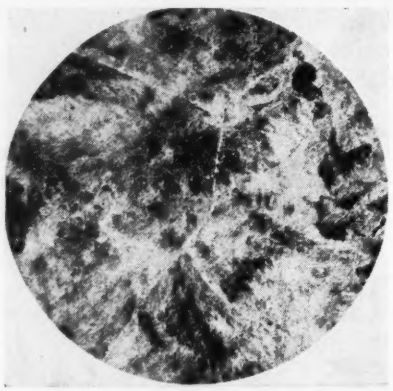


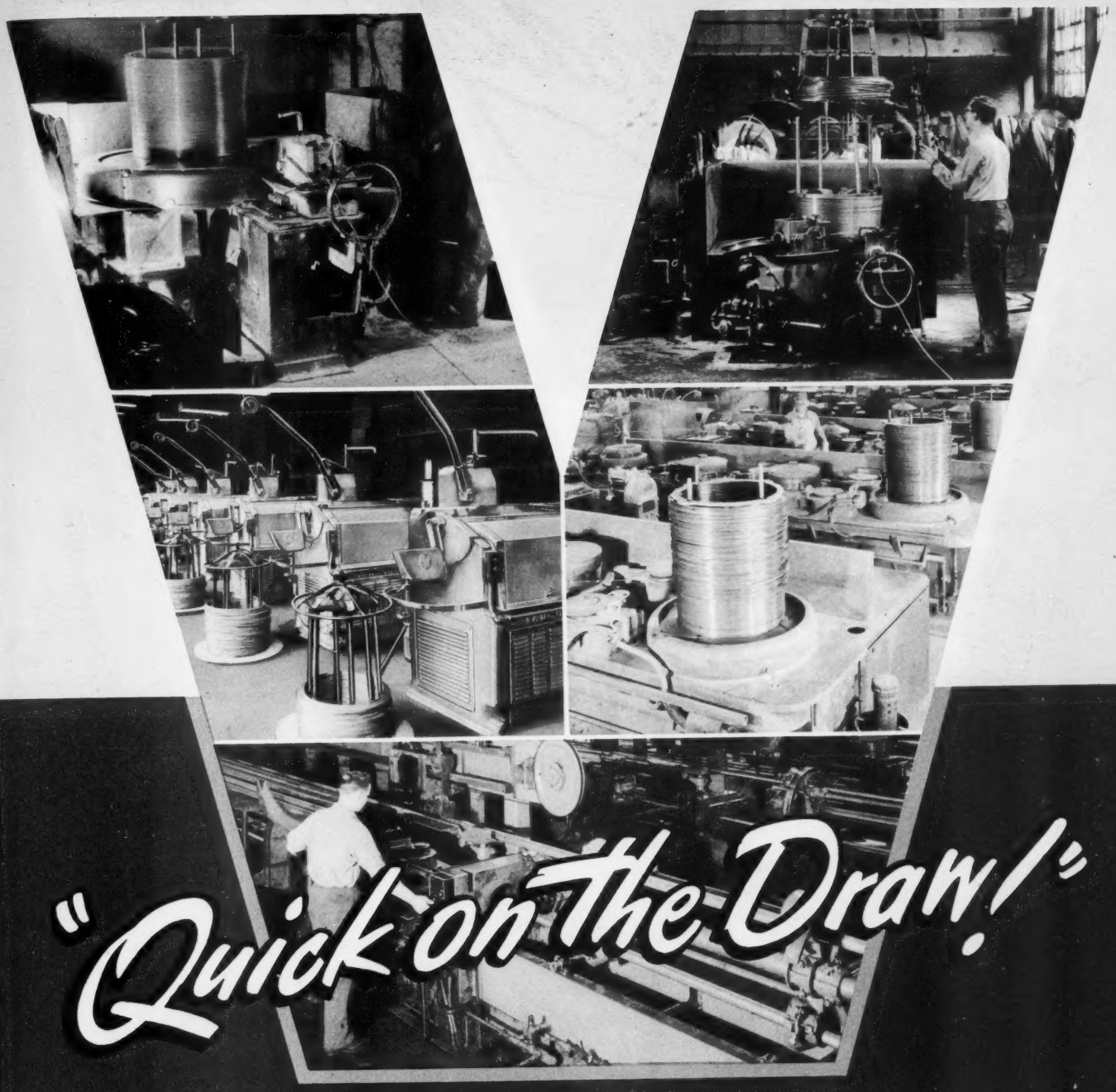
Fig. 16—Photomicrograph of weld heated at 2000°F for 20 minutes to diffuse oxide line.

THE only other source was the invisible oxygen or oxide film which is formed on the end of the rod after surface preparation by exposure to air. A correlation was made on rods prepared and welded immediately as against those held for a period of time and then welded. Those prepared and welded immediately had a thinner oxide line than those held for a few days. This indicated that welding im-

(*Please turn to page 984*)

TABLE III
RESULTS OF WIRE DRAWING PRESSURE WELDS

Group No.	Gas	End Preparation	Upset Preparation	Number of Welds	Number failed in Wire Drawing
I	H_2	Square	Ground off	12	9
II	H_2	Square	Forged back	18	14
III	H_2	Square	Forged back + 20 Min. @ 2000°F	30	30
IV	CO	Bevel	Forged back	6	3
V	H_2	Bevel	Ground off	5	5
VI	CO	Bevel plus filing in chamber.	Ground off	5	5
VII	CO	Square	Forged back	5	2



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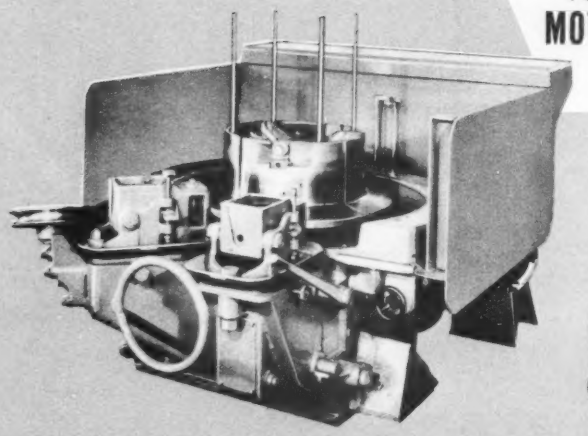

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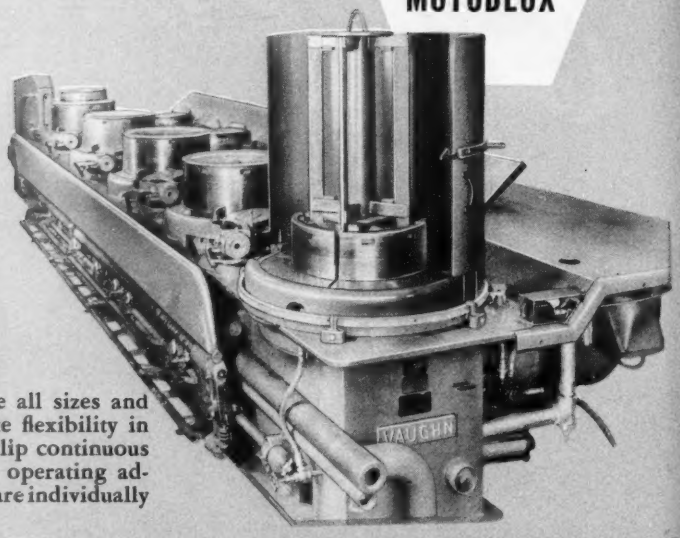

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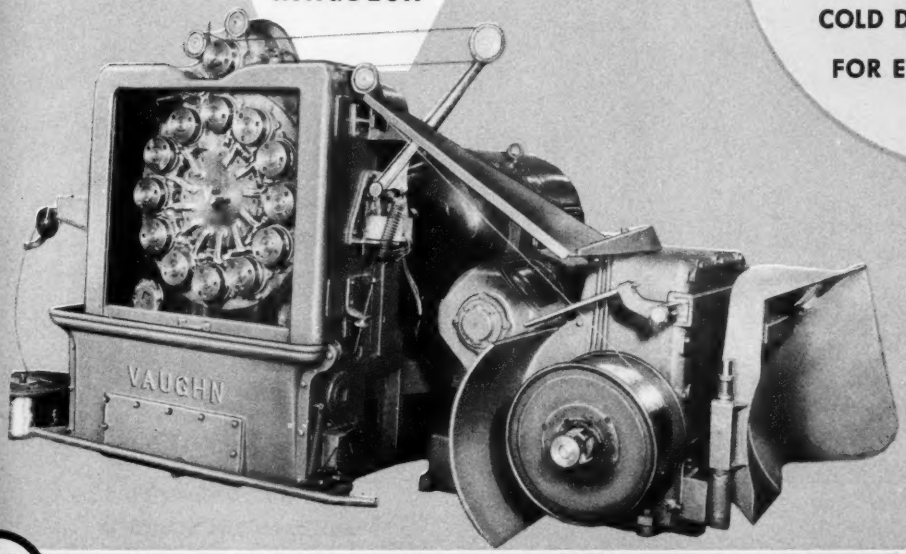

The Vaughn RINGBLOX Circular Tandem Machines produce intermediate, fine and very fine sizes of wire in steel, aluminum, copper and their alloys—at high rates of speed, with profitable efficiency. Many-score of these unique Vaughn machines are now in daily service.

V

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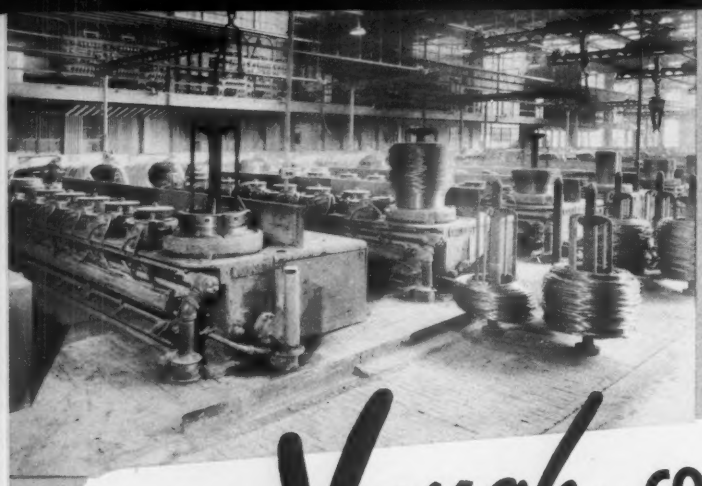

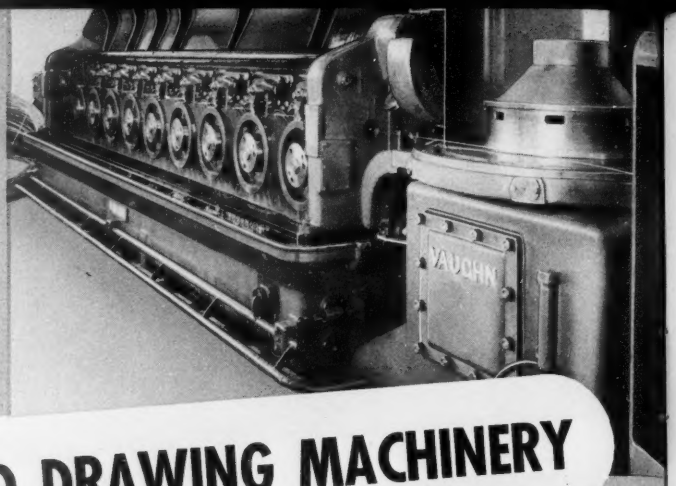

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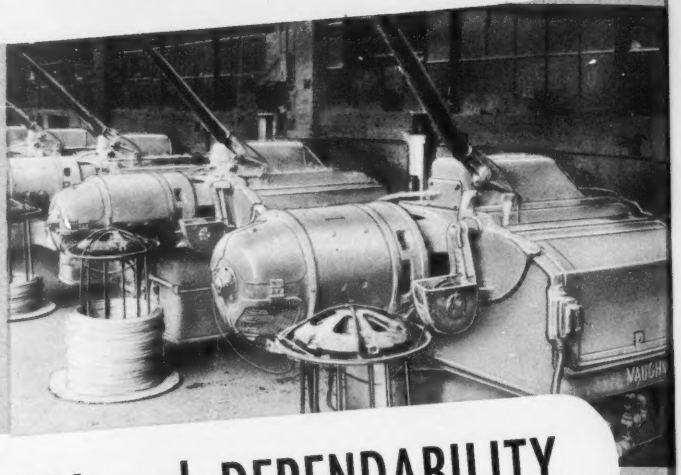

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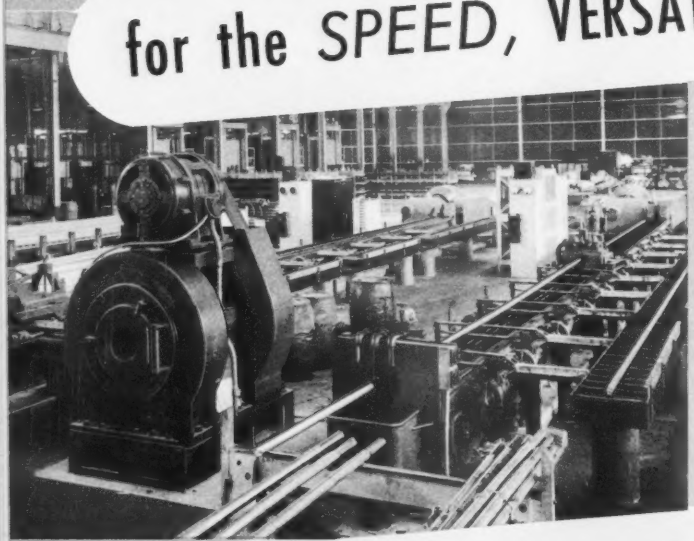

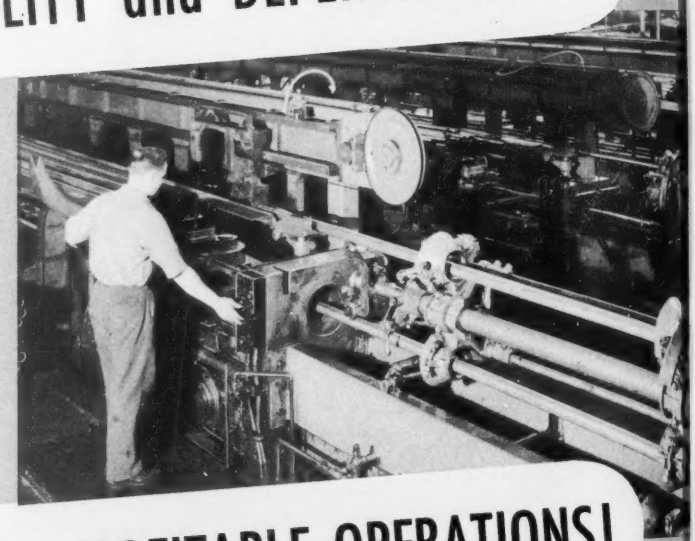

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Litho in U. S. A.

Back Pull Wire Drawing

By Dartrey Lewis
Chief Engineer Development Engineering

and

Howard J. Godfrey
Asst. Chief Engineer Development Engineering

John A. Roebling's Sons Company
Trenton, N. J.

Wire men have pondered back-pull drawing for ten years. This paper throws additional light on the practicability of the principle, based on actual experience.

THE subject of Back Pull Wire Drawing is by no means unfamiliar to the Wire Association. Several papers have been presented to it in the past, each of which has advanced our knowledge of the subject. The present paper describes a continuous wire drawing machine with controllable back pull which has recently been installed by John A. Roebling's Sons Company.

★ ★ ★

BACK pull has existed in wire drawing ever since the use of continuous machines, and the slipping capstan machine permits some control over the back pull according to the number of wraps on the capstan. However, it was not until recent years that it was suggested there might be certain advantages to the use of back pull.

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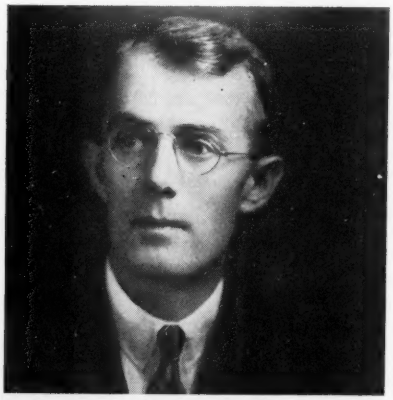

DARTREY LEWIS

Dartrey Lewis was born and educated in England where he graduated as Master of Metallurgy from the University of Sheffield in 1921. He came to this country in 1927 and was Research Engineer at the American Chain Co. for six years. He then became Chief Engineer of Hancock Division of Manning, Maxwell & Moore for seven years, and for the past eight years has been Chief Engineer, Development Engineering, for John A. Roebling's Sons Company.

THE first patent dealing with back pull was issued in Germany in 1926(1). The first reported experimental work was by **F. C. Thompson**(2) in England in 1933. One striking thing reported by him was that the die could be easily pushed along the wire with the fingers when back pull was used. In this country in 1935, **Mr. P. M. Mueller**(3) discussed before this Association the reduction of die friction by application of back pull. Also **Mr. L. Simons**(4) reported on back pull wire drawing experiments on a laboratory scale. **Mr. K. B. Lewis**(5) discussed the relation of back pull to die pull, and in 1939, **H. A. Stringfellow**(6) introduced the idea of reactive wire drawing in which the back pull was made a definite proportion of the forward pull. However, it was not until 1947 that the Marshall Richards Machine Company Limited in England, produced the first continuous wire drawing machine working on the back pull principle.

★ ★ ★

Description of Back Pull Wire Drawing Machine

IN the Fall of 1948 John A. Roebling's Sons Company installed a Marshall Richards machine at their Roebling plant. This paper describes their experience with it.

★ ★ ★

TWO views of the machine are shown in Figs. 1 and 2. It is a 5-hole machine with 22″ diameter water and air cooled blocks and water cooled dies. It will draw high carbon wire in sizes .060″ to .135″ at speeds ranging from 600 to 1400 F.P.M. Fig. 2 shows that the wire passes directly from block to block. The instrument panel gives the following information:

1. **Die pressure in pounds at each die.**
2. **Block pull in pounds at each block.**
3. **Finishing speed, F.P.M.**
4. **Armature current.**

★ ★ ★

IN order to measure die pull the die box is pivoted and the die pressure operates a hydraulic capsule. The die pressure is shown on a direct reading pressure gauge.

★ ★ ★

THE motor torque is obtained by multiplying the reading of a torque meter by the armature cur-

HOWARD J. GODFREY

Born April 24th, 1909 in Needham, Mass. Attended schools in Needham and graduated from Tufts College in 1931 with a BS. in Civil Engineering. Held Research Fellowship at Lehigh University from 1931-33 and graduated with M.S. in Civil Engineering. From 1934-1937 was Research Engineer with John A. Roebling's Sons Co. From 1937-1941 was Engineer of Tests at the Fritz Engineering Laboratory at Lehigh University. In 1941 became Development Engineer with John A. Roebling's Sons Company.

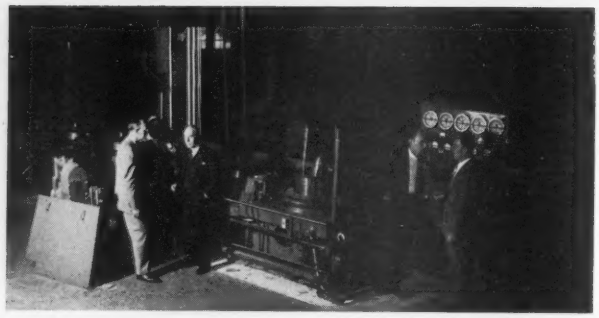

Fig. 1 — Marshall Richards five die back pull wire drawing machine.

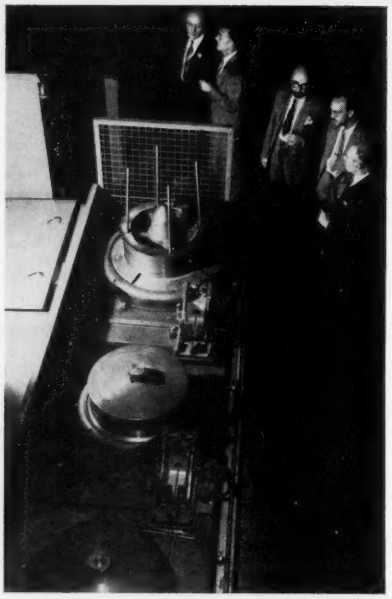

Fig. 2—Marshall Richards five die back pull wire drawing machine showing how the wire goes direct through the die from block to block.

rent. The block pull may be calculated from the motor torque by allowing for the gear ratio, gear efficiency and block diameter.

★ ★ ★

MOTOR field rheostats are provided for adjustment of the torque of the motors.

★ ★ ★

THE machine is threaded up and started as follows: The wire is pointed and passed through the first die, and a puller is attached. The foot control pedal is pushed and the torque of the first block is increased by means of a rheostat in front of the machines until the block turns slowly. When the block is full of wire it is stopped by releasing the foot pedal and the torque is then reduced slightly so that the block will not quite pull the wire through the die. This adjustment results in a low back tension on the wire going into the second die. A wooden faced clamp holds the wire in place on the block while the second die is threaded. This procedure is repeated with each block. When the machine is ready to run it is started by means of the foot pedal and accelerated to operating speed by pulling a waist high bar.

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THE die pressure indicators have loose red hands which are set to the "natural" die pulls. The natural die pull is the die pull without back pull and can be determined during threading up or at any other time by pulling wire through the die without back pull.

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DURING running, the die pulls may be adjusted to the desired fraction of the natural die pull by making appropriate adjustments of the block pulls. There is a set of motor field rheostats on the control panel for this purpose. Also a rheostat is provided for controlling the finishing speed.

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THE adjustment of the machine is not as complicated as it may sound. However, it is necessary to make an adjustment of block torque which is an operation not required with conventional machines.

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FIG. 3 shows a schematic electrical wiring diagram. Control of back pull is obtained quite simply by arranging the motors so their armatures are in series and their fields in parallel.

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THE motor torque is proportional to armature current times field strength. Since the same armature current flows through all motors, the relative torques will be proportional to the individual motor field strengths, which are adjusted by resistances F1 to F5.

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THIS arrangement allows the motors to be accelerated to full speed without breaking the wire because although the torques are increased during acceleration, the torque ratios between the blocks remain constant. The overall machine speed is adjusted by simultaneously changing all field strengths by resistance F6.

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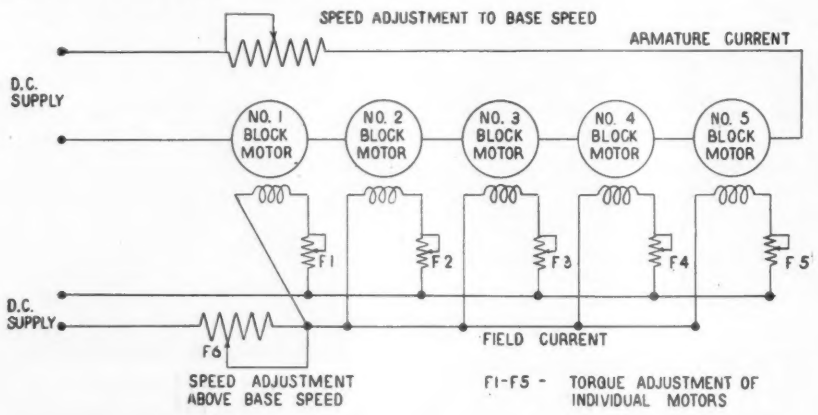

Fig. 3—Schematic electrical wiring diagram of Marshall Richards machine.

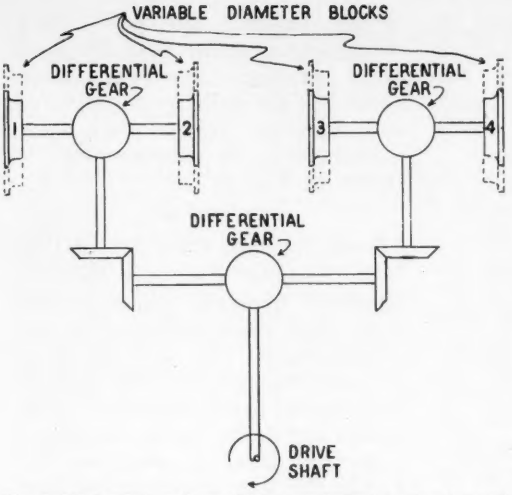

Fig. 4—Mechanical analogy which is equivalent to the electrical drive used on the Marshall Richards machine.

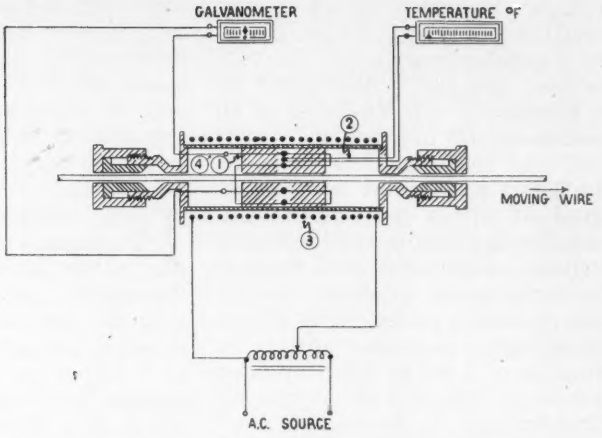

Fig. 5—Device for measuring surface temperature of moving wire. When the copper cylinder and the wire are at the same temperature, no heat transfer occurs.

THE mechanical effect of the electrical design is similar to a differential gear arrangement, as shown in Fig. 4. For simplicity this diagram shows 4 blocks of variable diameter at 1, 2, 3 and 4. Each pair of blocks is driven from a differential gear similar to a car rear axle. The two differentials are in turn driven from a third differential. With identical differentials the relative pull at each block will depend upon block diameter. Varying motor field strength is equivalent to varying block diameter in this analogy. The blocks may run at any speed relative to one another but will always have the same torque relationship to one another for any particular set of block diameters. With a constant speed drive, individual block speeds may vary in any manner but the sum of the speeds will be a constant.

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FROM a mechanical point of view the machine has a number of unique features, the principle ones of which are listed below:

1. **Wire passes directly through die from block to block.**
2. **Block pull is adjustable to any required torque and after adjustment remains in constant ratio with the torque of the other blocks at all speeds.**
3. **Any draft from 0% up may be used on any block.**

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BECAUSE the use of back pull reduces die friction, it was decided to devise a means for measuring the temperatures of the moving wire. The device used is shown in Fig. 5. It is based on the principle that when a heated copper cylinder is placed around the moving wire there will be no heat transfer between the wire and the copper cylinder if they are both at the same temperature.

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THE temperature of the copper cylinder is measured by a thermocouple (2) which when properly adjusted indicates the surface temperature of the wire. The copper

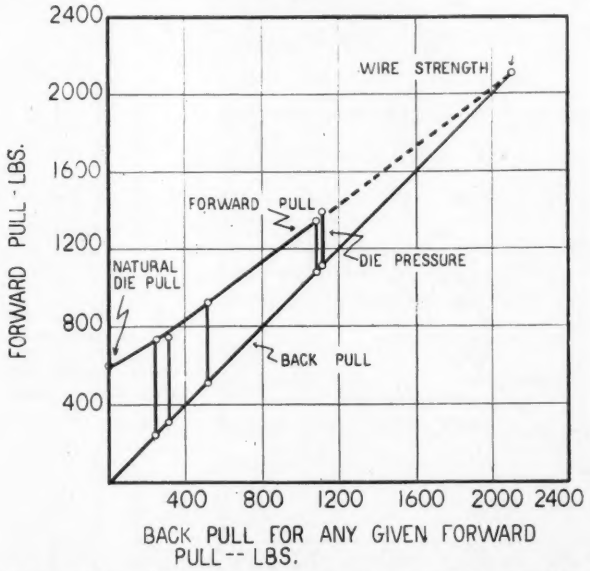

Fig. 6—Relation between back pull and forward pull for .75% carbon steel wire with a 20% draft.

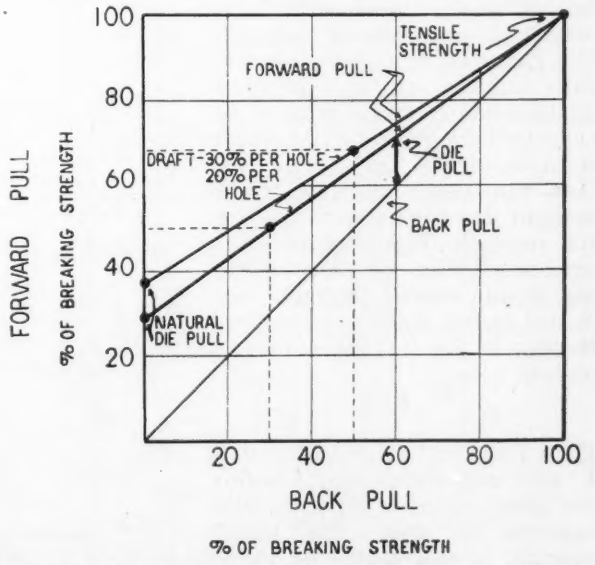

Fig. 7—Relation between back pull and forward pull for .75% carbon steel wire with 20 and 30% drafts.

cylinder is heated by an electric resistance winding (3) controlled by a variable transformer. The rate of heat transfer is determined by a thermopile (4) consisting of 10 thermocouples in series, with their hot and cold junctions arranged to detect any radial temperature gradient within the copper cylinder. The temperature of the copper cylinder is adjusted until there is no temperature gradient, indicating no heat transfer. This adjustment can be completed during the running of a coil of wire. Stuffing boxes are provided to prevent air flow through the device. Temperatures of moving wire at speeds up to 1400 F.P.M. have been measured.

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Experimental Results

THE Marshall Richards machine was set up in the Wire Mill, serviced in the same way as other wire drawing machines and operated by the regular wire drawing personnel. Observers were used to record the results and the drawn wire was tested for quality.

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THE relationship between back pull, forward pull and die pull was first determined. A typical set of data is plotted in Fig. 6 in which .187″ diameter lead patented .75% carbon rod was drawn five 20% holes to .105″ diameter. The data is for the final hole and represents six conditions of back pull. This figure shows that the forward pull falls on an approximately straight line from the natural die pull (no back pull) to the tensile strength of the drawn wire, and that the back pull falls on a straight line from zero to the tensile strength. This diagram is in agreement with previous works[8] and enough similar diagrams were plotted to feel that the generalized diagram in Fig. 7 is approximately correct.

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FIG. 7 applies to high carbon steel wire and shows drafts within the usual range of 20% to 30% reduction in area. The tensile strength is represented as 100%. In this diagram the die pull is the vertical distance between the forward pull and back pull lines. It will be seen that the die pull is progressively reduced from the natural die pull to zero as the back pull is increased to the tensile strength of the wire.

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THIS curve explains **F. C. Thompson's** statement that the die pull can be reduced so that the die can be pushed along the wire with the fingers. However, he was drawing at very slow speeds up to 3 inches per minute. At commercial wire drawing speeds we found that there were very definite limitations to the amount the die pull may be reduced without getting into undue breakage of wire.

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WHEN the die pull was one-half of the natural die pull, the machine operated with too much wire breakage for practical use. A more useful limit would be a die pull of two-thirds the natural die pull. Under these conditions the back pull is about one-third of the tensile strength.

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IT should be pointed out that Fig. 7 has been constructed from the die pulls and block pulls as indicated on the instrument panel and include any instrument errors which may have existed.

★ ★ ★

THE natural die pulls were somewhat lower than obtained in a previous investigation in which the die pulls were measured on a machine equipped with a dynamometer. A comparison is shown in Fig. 8.

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IT will be seen from Fig. 8 that the natural die pull for the Marshall Richards machine was lower than when measured by the dynamometer. The wire drawn on the machine with the dynamometer was cleaned in sulphuric acid, lime coated and drawn using a pure dry soap. The drawing speed was 115 F.P.M. The wire drawn on the Marshall Richards machine was cleaned in sulphuric acid, "sul," coated, borax coated and drawn using a proprietary soap. The drawing speeds varied but were usually about 1200 F.P.M.

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IT is not known whether the lower die pull on the Marshall Richards machine was due to drawing conditions, but it is suspected that some of it was due to instrument errors.

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THE fact that the die pull can be reduced by the application of back pull means that the pressure between the wire and the die is reduced in the same proportion (the die pull is the axial component of this pressure).

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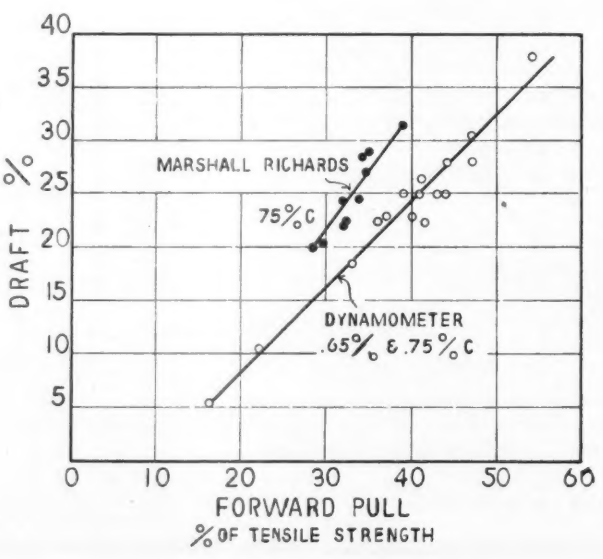

Fig. 8—Natural die pull expressed as a percentage of the tensile strength of the drawn wire.

REDUCTION in pressure means less friction between the wire and the die. Three important results follow from less friction:

1. **Longer die life.**
2. **Less surface heat on wire.**
3. **Less horsepower.**

* * *

NO investigation has been made of die life because of the difficulty of obtaining reliable figures on account of the many factors affecting die life. It is understood that the British Iron and Steel Research Association, who have also made an investigation of this machine, found some improvement in die life.

* * *

THE effect of surface heat on the wire will be discussed under the torsion test results.

* * *

THE diagram in Fig. 8 can be used to calculate the horsepower developed at the blocks during wire drawing. This has been done for .187" diameter high carbon rod drawn 5 holes to .095" diameter (a) without back pull, (b) with low back pull and (c) with high back pull. The results are shown in Fig. 9. This figure shows a saving in horsepower of 7% for low back pull and 11.4% for high back pull. The actual power consumption for a number of test runs for the machine operating at high back pull ranged from 84%

Power Consumption
187" Rod Drawn 5 Holes to .095"

Zero Back Pull - Forward Pull Ratio at 5th Hole = .32

Block No	1	2	3	4	5
Speed-fpm	438	575	754	990	1300
Back Pull - 0 lb	0	0	0	0	
Die Pressure - 1560 lb	1190	1030	750	580	
Forward Pull - 1560 lb	1190	1030	750	580	
Block Pull - 1560 lb	1190	1030	750	580	
H P in Dies - 20.65	20.7	23.5	22.5	22.9	
H P in Blocks - 20.65	20.7	23.5	22.5	22.9	

Total Horse Power - 110.3 = 100 %

Minimum Back Pull - Forward Pull Ratio at 5th Hole = .53

Block No	1	2	3	4	5
Speed-fpm	438	575	754	990	1300
Back Pull - 0 lb	535	648	678	530	
Die Pressure - 1560 lb	995	778	512	408	
Forward Pull - 1560 lb	1530	1426	1190	938	
Block Pull - 1025 lb	882	748	660	938	
H P in Dies - 20.65	19.60	21.30	20.20	21.0	
H P in Blocks - 13.60	15.35	17.10	19.80	36.9	

Total Horse Power - 102.75 = 93.0 %

Maximum Back Pull - Forward Pull Ratio at 5th Hole = .72

Block No	1	2	3	4	5
Speed-fpm	438	575	754	990	1300
Back Pull - 0 lb	755	1023	1090	1027	
Die Pressure - 1560 lb	913	622	369	248	
Forward Pull - 1560 lb	1668	1645	1459	1275	
Block Pull - 805 lb	645	555	432	1275	
H.P in Dies - 20.65	19.10	18.70	19.85	19.5	
H P in Blocks - 10.65	11.25	12.65	12.95	50.3	

Total Horse Power - 97.80 = 88.6 %

Fig. 9—Analysis of the effect of back pull upon horsepower required to draw wire. * * *

Welcome to
Hello, There!
Speaking for the Magnus Chemical Company, Harold Trembicki extends to the members of the Wire Association a most hearty welcome to Chicago. We're glad to have you back, and are looking forward to seeing a lot of old friends, and making a lot of new ones.
Magnus
METAL COAT
When the day's work is done, and you're ready to drop— drop in and relax with us!
Metal Coating Division

Chicago!

- Most of you already know about Magnus Metalcoat #267. You know that it was the first successful coating compound to replace lime and baking . . . and, today, it still remains the *only* successful one.

- By this time, you've probably heard about our new Metalcoat #267 process for drawing stainless steel wire without a metallic coating. That's another "first" for Magnus, and it's doing fine.

- And then there's cold heading. This is a "natural" for Metalcoat #267, and we've made a great deal of progress. This will be the next big "first" for Magnus.

- That's not all, by any means. We have a lot of new ideas we'd like to discuss with you, and the Convention gives us a wonderful chance to do this. For instance—a *really continuous* system of drawing wire, all the way from heat treating, through the acid cleaning, spray rinse, Metalcoat #267 coating bath, drying and drawing . . . to the finished bundle of wire! Sound like a pipe dream? So did the idea of drawing wire without lime and without baking . . . remember?

Yes, we'll have a lot to discuss, so come in and see us. You'll find the welcome mat out at Magnus Headquarters . . . we'll be looking for you!

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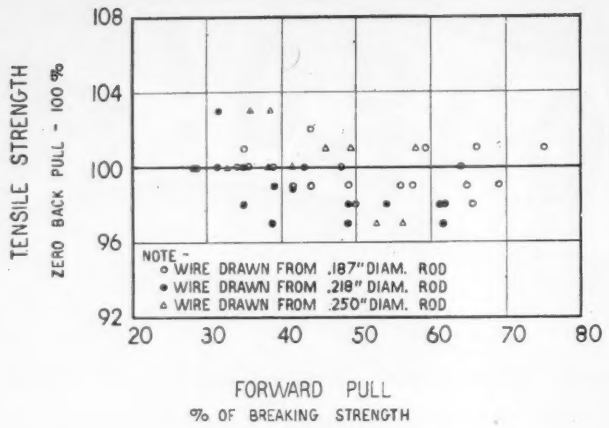

Fig. 10—Effect of back pull upon tensile strength of .75% carbon steel wire (back pull is not shown as such by the increased forward pull which it causes). * * *

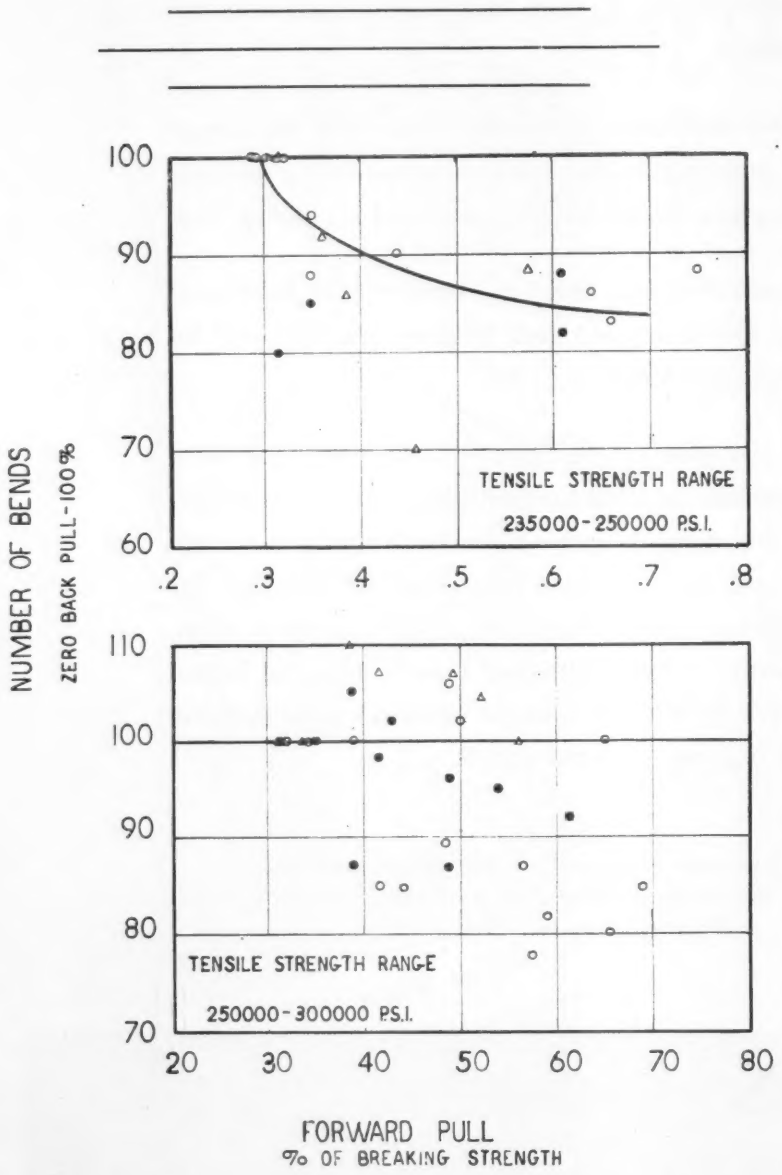

Fig. 11—Effect of forward pull (caused by back pull) upon bends over a mandrel ten times the wire diameter for .75% carbon steel wire. * * * * * * * * * * *

to 105% of the power consumed when operating at low back pull. This may be compared with Fig. 9 which shows that the power used at high back pull was 95% of the power used at low back pull.

★ ★ ★

Effect of Back Pull on Quality of Wire

A SERIES of tests were made to determine the quality of wire produced. .187", .218" and .250" diameter lead patented .75% carbon rods were drawn on the machine. All the drafting was 5 holes with equal drafts per hole. The drafts were approximately 20%, 24%, 28% and 32%. The .187" diameter rod was drawn to .105", .095", .082" and .072"; the .218" diameter rod to .125", .107", .095", and the .250" diameter rod to .135", .125" and .107" diameters.

★ ★ ★

TESTS were made with maximum and minimum back pulls at the maximum machine speed. It was found that the minimum machine speed was increased by application of maximum back pull, so a series of tests were made at this speed using both maximum and minimum back pulls. Finishing speeds ranged from 675 to 1375 F.P.M. For comparison with the wire drawn with back pull, the same wire was drawn under approximately the same conditions of drafting and speeds on a conventional continuous wire drawing machine which operated with practically no back pull. A typical set of data is shown in Table I. Five coils of wire were drawn for each series of tests. Samples for tests were taken from the back end of each coil. Two tensile, 3 bend and 3 torsion tests were made on each coil. In Table I the U.T.S., E % and R.A. % are each the average of 10 tests, and the torsions and bends are each the average of 15 tests. For this work a total of about 75,000 lbs. of wire was drawn.

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Effect on Strength

FIG. 10 shows the effect of back pull wire drawing upon the

tensile strength. In this chart the tensile strength of wire drawn on the Marshall Richards machine is expressed as a percentage of the tensile strength of the same wire drawn with the same drafts and speeds on the conventional machine. In this way wires of different diameters and strengths can be compared on the same chart.

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IN this chart, as in others to be described later, the magnitude of back pull is shown not as back pull but as forward pull expressed as a percent of the tensile strength of the drawn wire. The use of forward pull gives a clearer picture of the effect of back pull. Forward pulls in the range 29 to 38% are required for drafts of 20 to 32% reduction in area without back pull. Forward pulls above this are due to the application of back pull. The relation between forward pull and back pull has already been shown in Fig. 7.

★ ★ ★

IN Fig. 10 distinguishing symbols are used for wire drawn from the different sizes of rods. These same symbols are used on all the other charts. It will be seen from Fig. 10 that back pull makes no significant change in the tensile strength of the drawn wire.

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Effect on Bends and Reduction of Area

THE ductility of the wire was measured by bends over a mandrel ten times the wire diameter and by reduction of area in the tensile test.

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FIG. 11 shows the bend test results. This figure shows that wire within the tensile range 235,000-250,000 p.s.i. has lower bends at higher forward pulls (and back pulls). The trend is not so clear in wire in the 250,000-300,000 p.s.i. tensile range and the results are scattered possibly because the wire is somewhat overdrawn.

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FIG. 12 shows the effect of back pull upon the reduction of area in the tensile test. This figure is divided into four sections according to the amount of drafting.

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THE reduction in area is lowered by increasing forward pull (and back pull). Also this effect is greater with light drafts than with heavy drafts. On these curves the points are averages of 10 tests. There was considerable spread in the individual tests at high forward pulls and some quite low readings were obtained. Investigation of the low results showed that the wire had a cuppy type tensile fracture, as shown in Fig. 13. Apparently wire drawing with back pull reduces the ductility of high carbon steel and at higher values of back pull may cause internal rupturing or cupping of the wire.

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SOME search has been made for a reason for this effect. **Professor P. W. Bridgman**(7) has found that if a sample of heat treated high carbon steel is pulled in tension the reduction of area is affected by hydrostatic pressure and that lower hydrostatic pressures give lower reductions of area. (See Fig. 14) **Bridgman's** experiment has a close relationship to our problem. In wire drawing, the die pressure on the wire is somewhat like hydrostatic pressure and the forward and back pulls are similar to the tensile loads in the tensile test. It might be expected, therefore, that when the die pressure is reduced by application of increased forward and back pull that the reduction of area of the drawn wire would be lower, just as we have found. Further light on the question is obtained by considering the fracture strength of wire. For example, the true stress-strain diagram for a high carbon cold drawn wire is shown in Fig. 15.

★ ★ ★

ORDINARILY the tensile strength of a wire at fracture is figured as the maximum load divided by the original area. In Fig. 15 the tensile strength has been determined by dividing the actual load by the actual area as the wire necked down and finally broke. The resulting tensile strength at fracture was found to be 310,000 p.s.i. The strength is sometimes called the fracture strength of the material or the

TABLE I

Series B—.187″ Diameter Lead Patented Rod. Drawn 5 holes to .095″ diam, wire. Average reduction per hole 23.8%. Total reduction 73.1%. All blocks filled to puller slots.

Series	Machine	Speed F.P.M.	Back Pull	For'd* Pull Ratio %	U.T.S. p.s.i.	Recov. Elong. 10″—%	Torsions 100-D	Split Torsions %	R.A. %	Bends over 10-D
B	Conventional	1250	0	32.2	248,500	1.6	36	0	47.1	53
B-3	M-R	1250	Min.	48.1	252,300	1.6	35	0	45.8	47
B-4	M-R	1250	Max.	74.8	249,500	1.5	33	0	41.4	46
B	Conventional	1350	0	32.2	254,000	1.7	36	0	47.9	58
B-5	M-R	1350	Min.	43.6	253,500	1.4	31	56.0	43.3	49
B-6	M-R	1350	Max.	69.0	251,800	1.5	33	0	43.2	49

* Forward pull for 5th die expressed as percent of breaking strength of wire coming from die.

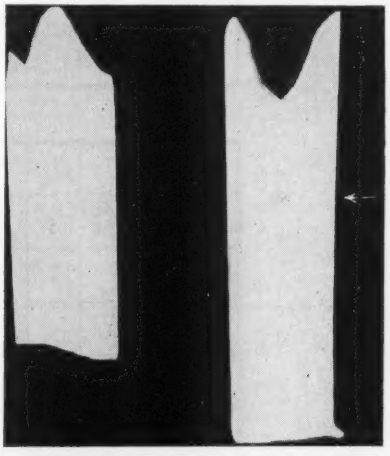

Fig. 13—Tensile fracture of .132″ diameter .75% carbon steel wire drawn with too high back pull. It shows a "cuppy" type fracture and an internal cup at arrow.

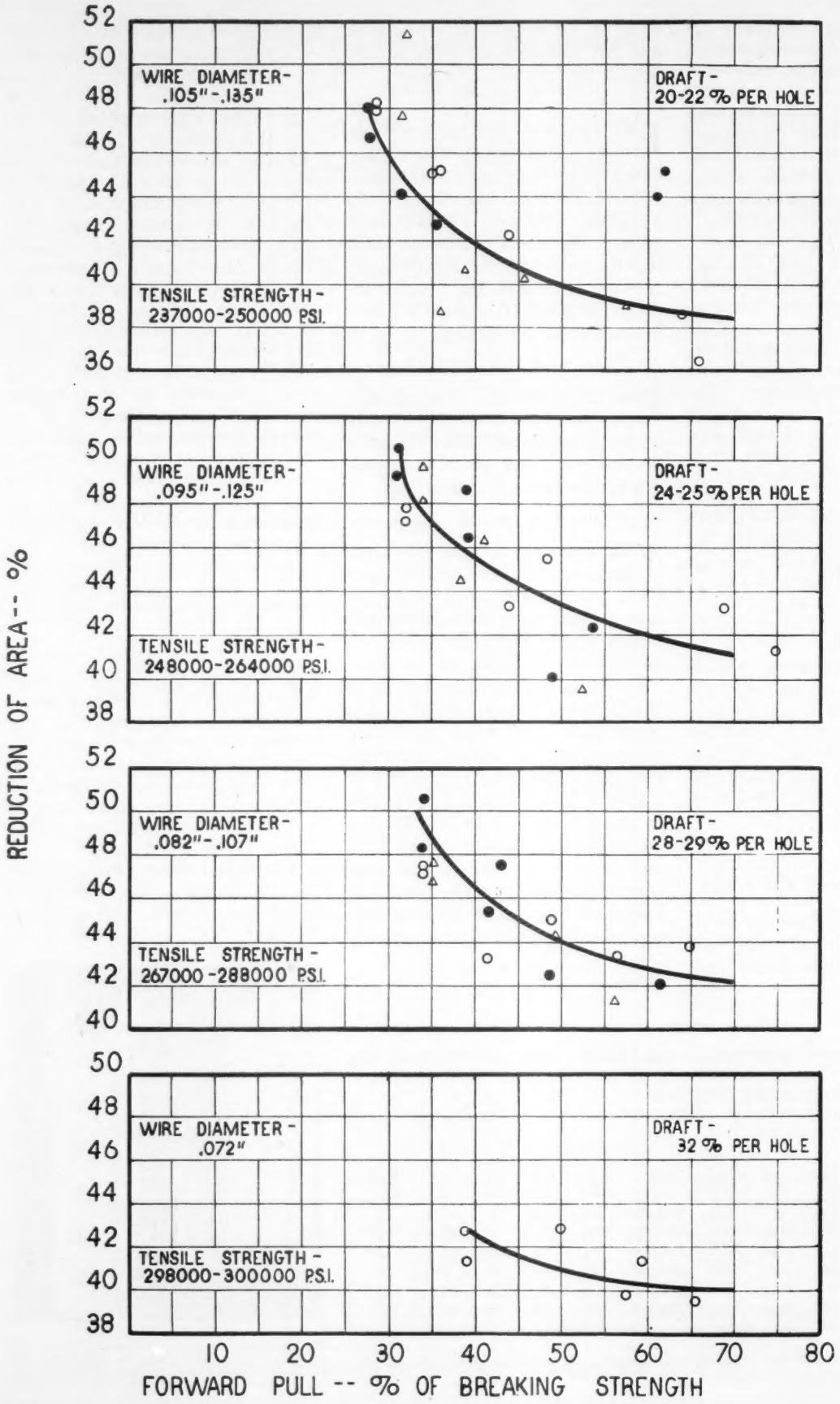
WIRE DIAMETER- .105"-.135"
DRAFT- 20-22% PER HOLE
TENSILE STRENGTH- 237000-250000 PSI.
WIRE DIAMETER- .095"-.125"
DRAFT- 24-25% PER HOLE
TENSILE STRENGTH- 248000-264000 PSI.
WIRE DIAMETER- .082"-.107"
DRAFT- 28-29% PER HOLE
TENSILE STRENGTH- 267000-288000 PSI.
WIRE DIAMETER- .072"
DRAFT- 32% PER HOLE
TENSILE STRENGTH- 298000-300000 PSI.
REDUCTION OF AREA -- %
FORWARD PULL -- % OF BREAKING STRENGTH

Fig. 12—Effect of forward pull (caused by back pull) upon reduction of area in the tensile test for .75% carbon steel wire. * * *

flow stress at fracture.

★ ★ ★

BRIDGMAN found for the steel previously referred to that the flow stress at fracture could be considerably increased if the material were broken while under hydrostatic pressure. This effect is shown in Fig. 16, where it will be seen that the fracture strength has been increased to the fantastic figure of 570,000 p.s.i.

★ ★ ★

ALL the foregoing is a high-brow way of saying it is better to elongate wire by squeezing it than by pulling it because it holds together better.

★ ★ ★

THIS statement is not only true for wire but for other materials as well. For example, a piece of modeling clay can be elongated any desired amount by squeezing it in the fingers but it cannot be elongated much by pulling before it comes apart.

★ ★ ★

THIS rather crude example makes us realize that wire drawing would not be possible at all if it were not for the pressure of the die on the wire. It is the die pressure which makes it possible to reduce the wire area 25% with a forward pull of less than half the breaking strength.

★ ★ ★

WHAT does all this mean from a practical point of view? It means this: back pull must be used with caution because the increased forward pull which results from it tends to produce incipient internal ruptures. For this reason it is recommended that the forward pull not exceed 50% of the tensile strength of the material.

★ ★ ★

UNDER these conditions in high carbon wire there is a lowering of the reduction of area in the ten-

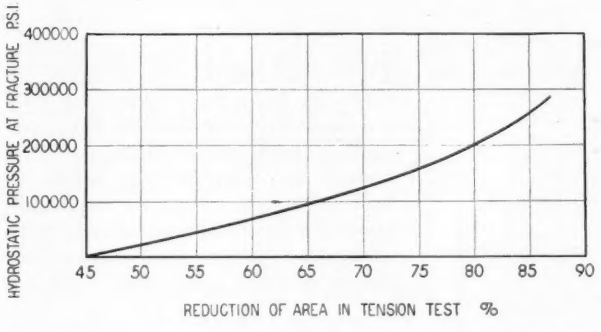

Fig. 14—Reduction of area in the tensile test for heat treated high carbon steel tested within a chamber containing hydrostatic pressure. (From Prof. P. W. Bridgman's data.)

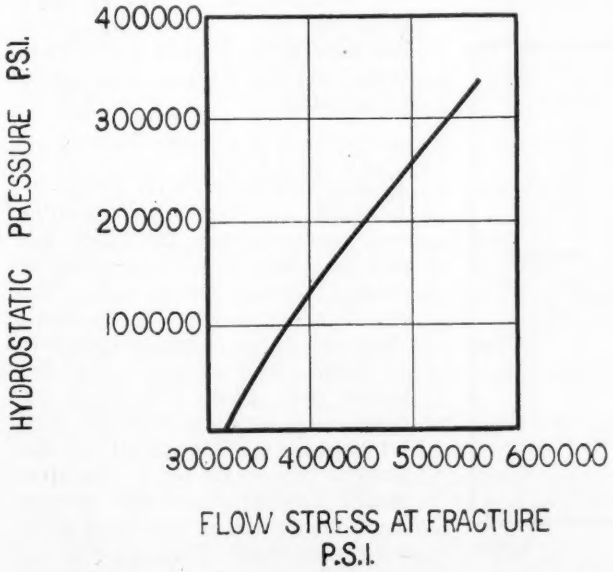

Fig. 16—Flow stress at fracture for tensile tests of heat treated high carbon steel tested within a chamber containing hydrostatic pressure. (From Prof. P. W. Bridgman's data.)

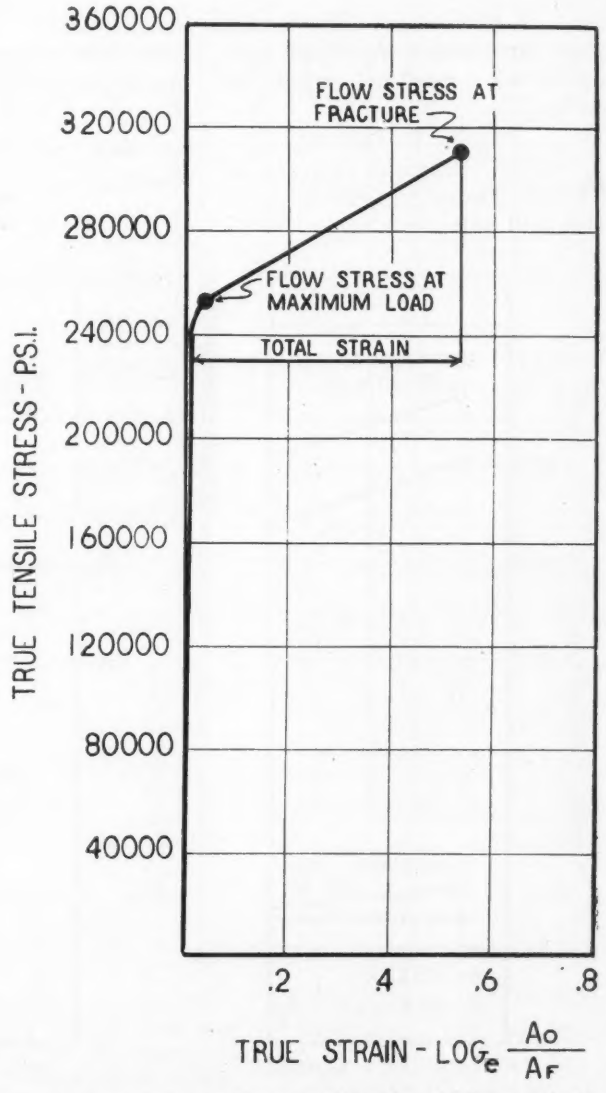

Fig. 15—True stress-strain diagram for high carbon cold drawn steel wire. In this diagram the true tensile stress is calculated from the actual wire diameter as it necks down.

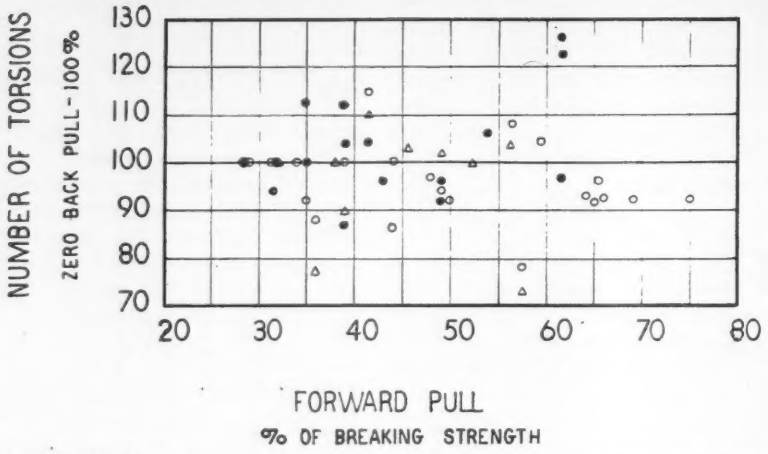

Fig. 17—Effect of forward pull (caused by back pull) upon the number of twists in the torsion test for .75% carbon steel wire.

sile test from about 50% to not under 40% which, for many wire applications, may not reflect in service life.

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A VERY practical evidence of the lowering of ductility by back pull wire drawing is the effect on welds. There are many more weld breaks with back pull wire drawing than without. Welds must be well made and drawn with low back pull to draw without breaking.

★ ★ ★

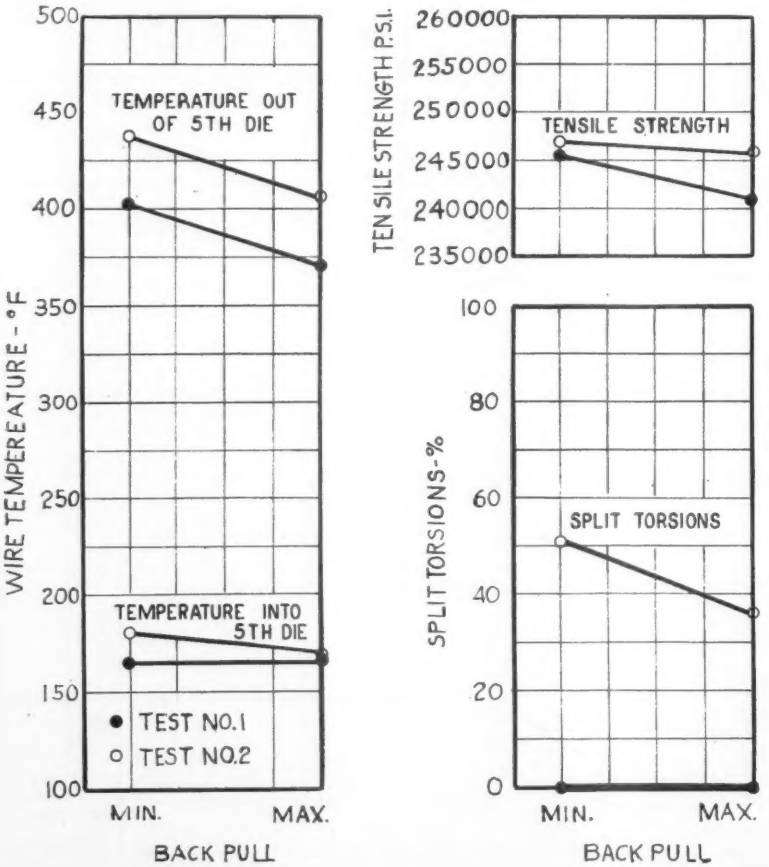

Fig. 19—Effect of back pull upon the surface temperature, tensile strength and split torsions for .095" diameter .75% carbon steel wire drawn 5 holes from .187" diameter rod.

Effect of Torsions

FIG. 17 shows that the number of torsions in 100 diameters is not significantly affected by forward pull (and back pull).

★ ★ ★

IN addition to obtaining the number of torsions, we observed whether the wire split longitudinally during the torsion test. Many wire men will agree that splitting during the torsion test is a greater indicator of wire quality than the actual number of torsions.

★ ★ ★

WE found, as shown in Fig. 18, that an increase in forward pull (and back pull) on the Marshall Richards machine reduced the percentage of split torsions.

★ ★ ★

IT is well known in the wire industry that too much heat during wire drawing causes split torsions in high carbon wire. For this reason an attempt was made to determine the effect of back pull upon the temperature of the wire using the temperature measuring device already described.

★ ★ ★

THE effect of back pull on wire temperature is shown in Fig. 19, from which it will be seen that the temperature, with high back pull, was 30°F. lower than with low back pull. Fig. 19 also shows fewer split torsions at lower wire temperatures.

★ ★ ★

FOR comparison with these results, a conventional machine was operated with the block full and half full of wire in order to change the wire temperature. The results are shown in Fig. 20, which shows that the wire temperature is about 50°F. lower with the blocks full. Here also there are fewer split torsions at lower wire temperatures. The effect of the amount of wire on the blocks upon tensile strength is much greater than the effect of back pull upon tensile strength. This may be because change in back pull affects surface temperature whereas change in amount of wire on the

block affects the temperature throughout the wire.

★ ★ ★

THESE tests show that both wire temperature and percentage of split torsions may be reduced by back pull. The magnitude of the effect is similar to that obtained by changing the amount of wire on the blocks.

★ ★ ★

Low Carbon Steel

ONLY a limited amount of experimental work has been done with low carbon steel wire. The procedure was similar to that used for the high carbon steel.

★ ★ ★

A TYPICAL set of test results is shown in Table II covering the drawing of .187″ diameter .05% carbon rod 5 holes to .078″ with 30% reduction of area per hole. The figures are averages for 5 coils with 2 tests made on the back end of each coil.

★ ★ ★

ALTHOUGH the reduction in area is slightly lower with back pull, it may be said from these tests and also from others not reported in detail that the use of back pull makes no significant change in the physical properties of low carbon steel.

★ ★ ★

DIFFICULTY was experienced in drawing with 35% reduction of area per hole because the back pull could not be easily adjusted low enough to prevent frequent wire breakage. To some extent the trouble may have been due to starting with a small rod (.187″ diameter). The die pulls were small and therefore difficult to adjust. However, it is to be expected that a lower draft per hole will be necessary when using back pull because of the limitation imposed by the forward pull.

★ ★ ★

WHEN drawing low carbon steel wire without back pull, the amount of drafting per hole is limited by the breakage which occurs when the draft is too high. Experience has shown that the draft may be within the range of 30% to 40% without undue breakage.

★ ★ ★

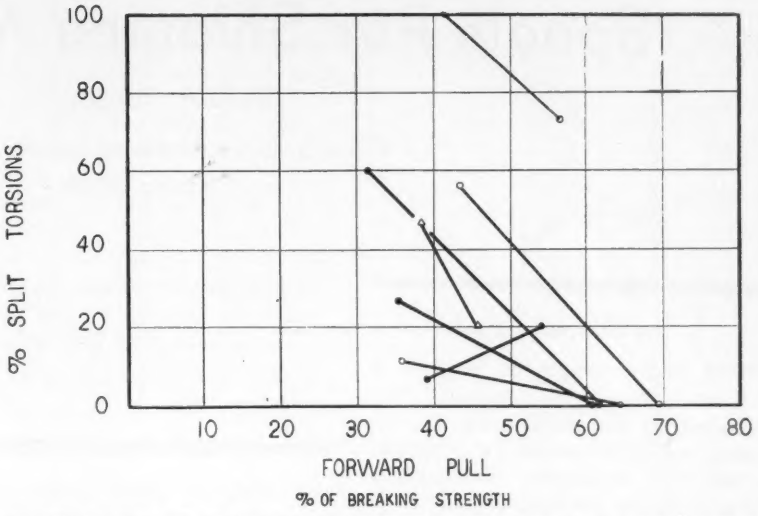

Fig. 18—Effect of forward pull (caused by back pull) upon split torsions for .75% carbon steel wire.

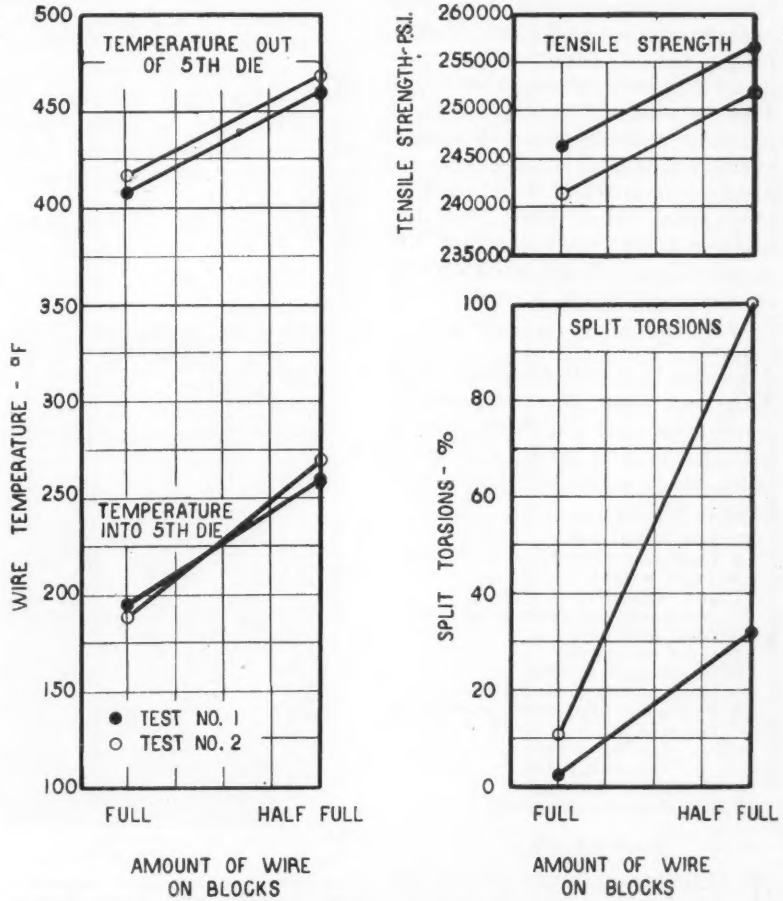

Fig. 20—Effect of height of wire on blocks upon the surface temperature, tensile strength, and split torsions, for .095″ diameter .75% carbon steel wire drawn 5 holes from .187″ diameter rod.

WHEN back pull is used, the forward pull is increased causing breakage unless the draft is suitably restricted. In our tests

(*Please turn to page 982*)

Spools For Shipping Magnet Wire

By F. A. Rappleyea

Chief Engineer, Hubbard Spool Company

Chicago, Illinois

A discussion of various types of spools for shipping magnet wire. Paper presented at Wire Association Convention, Chicago, Ill., October, 1949.

The Shipping Spool

TO many people it is just a nuisance—but a necessary nuisance that the purchasing department wants to obtain for nothing; that the production department wants to be perfect in concentricity, sturdy in construction with low maintenance; that the sales department wants to look beautiful and that management wants to be light to save money on shipping. This nuisance is a shipping spool for fine magnet wire. All of the above points and others, too, are desirable features of the ideal shipping spool. This, then, was the problem of the spool designer and in order to satisfy everyone certain compromises had to be made.

★ ★ ★

IN order to clarify the issue so as to show how the compromises were made the following list of both major and minor characteristics which a shipping spool must have is given—

1. Low initial cost
2. Good concentricity and accuracy
3. Light weight
4. Low maintenance cost
5. No cracks on working surface
6. Good durability
7. Good eye appeal
8. No nicking of head
9. Good stacking characteristics
10. Provisions for such accessories features as
    - (a) lug holes
    - (b) wire holes
    - (c) drain holes
11. Resistance to corrosion

★ ★ ★

THERE are a number of materials on the market from which such a spool can be made but usually any one material falls down in several things. Steel, wood, magnesium, aluminum, thermosetting and thermoplastic formulations and fibre glas were the chief materials considered. In any one general category there would be a great choice of alloy or types of formulations and, also, designs. A table listing the general properties of these materials is given as Table I. Later on after a complete analysis has been made a concluding table will be given showing how the various designs and materials meet the requirements as set forth previously.

★ ★ ★

F. A. RAPPLEYEA

Graduated BS in ME, degree Villanova College 1940. Graduate Work University Southern California — Aeronautical Engineering Professional Degree ME 1945. Associated with North American Aviation where he was in charge of Stress Analysis on Mitchell Bomber and Mustang fighter designs as well as others. Dow Chemical Company —6 years—Research Department in charge of Magnesium Design Division and also later Sales Engineer in Product Development. For past 2-½ years Chief Engineer at Hubbard Spool Company. Has published 15 papers on design in magnesium, magnesium research projects, spools, etc. Member of Advisory Board for Chicago Chapter of Institute of Aeronautical Sciences and ASM, SESA, IAS, ASME, etc. * *

THE first thing to consider in any one of these materials is design. The design must be such as to make good use of the special properties of the material selected. Starting with wood or steel or any combination thereof, a design can be made economically making use of the low cost materials and their inherent resiliency; but good appearance, low maintenance cost and a joint free surface are sacrificed. In both aluminum and magnesium a spool can be made consisting either of many formed parts or die cast as one or, at most, two pieces. All of these designs have been made and used at one time or another in the wire industry. None of them has given the final answer. A plastic spool incorporating fibre glas and having no joints over the working surface shows the best promise of becoming the ideal spool. Ordinarily, plastic spools fall into two classes, thermosetting and thermoplastic. The thermosetting spools are brittle and the thermoplastic are subject to cold flow. However, the fibre glas spool although made with a thermosetting resin exhibits no brittleness even when struck repeatedly with a hammer. Of course it has no tendency toward cold flow or creep. More will be said of this spool later. The designs tested in this study are shown in Figures 1-8. In order to get a basis of comparison only the six inch spool was used in all cases. The progression to the onepiece design can be noted by seeing that the wood metal spool has two joints on the working surface, the aluminum drawn and die cast have one each and the aluminum heat-treated, magnesium die cast and plastic spools have none.

★ ★ ★

WOOD METAL SPOOL

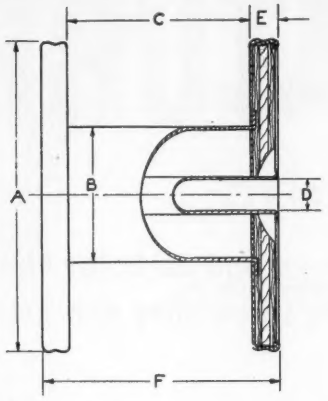

Figure 1

AFTER the design had been selected the first test was to wind the spool and see how much deflection under load was noted. Before showing these results it is necessary to say a word about the winding equipment, a picture of which is shown in Figure 9. This equipment is such that excessive tension can be applied. Although, in mill practice, it is common to have only 8,000 psi tension on fine wire, this machine gave considerably more being almost 15,000 psi even to the point where wire was being stretched. Therefore the results that are shown will be only comparative for the various spools and do **NOT** indicate the spread in service, which would be considerably less. For example, where one spool showed a spread of a 0.030" under this test, it only spread 0.004" when the same spool was tested in a fine wire mill. After these tests were made the spools were pulled in rings set in a Tinius Olsen testing machine. This machine is shown in Figure 10 and a spool is under test in it. The results of these tests are shown in Table II.

★ ★ ★

A CORRELATION of these two types of tests gives an approximate idea of the thrust load on the head of a spool under load. This is obtained by first winding the spool and noting the deflection under load and then pulling the spool in the machine as mentioned before until a comparable deflection is obtained. The load under this deflection gives an approximate idea of the load obtained by winding. This load is approximate because where winding gives a uniform load over the head, the rings in the testing machine give a concentrated load on the head. In addition it is difficult to wind under the same conditions twice in succession due to various factors.

FIBERGLAS SPOOL

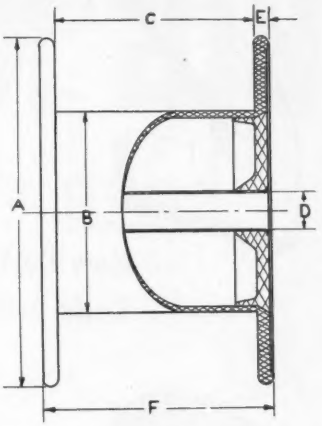

Figure 2

★ ★ ★

IN this strength comparison in Table II it is noted that the magnesium spool is the strongest with the aluminum spools coming next, followed closely by the fibre glas spool. The thermoplastic and wood-steel spools are a poor last. It is quite evident from this why the newer types of spools are supplanting the old conventional double head wood-metal spools.

★ ★ ★

TABLE I
PROPERTIES OF MATERIALS STUDIED

MATERIAL	DENSITY #/Cu. in.	ULTIMATE TENSILE PSI	TENSILE YIELD PSI	MODULUS OF ELASTICITY
PLYWOOD	.023	10,000	10,000	1.5×10^6
STRUCTURAL (Carbon Steel)	.283	60,000	38,000	29×10^6
MAGNESIUM	.065	34,000	22,000	6.5×10^6
ALUMINUM	101	33,000	18,000	10.1×10^6
FIBRE GLAS	.065	60,000 psi	———	3.0×10^6

TABLE II
TEST RESULTS WINDING AND PULL TESTS

TYPE SPOOL	AVERAGE DEFLECTION UNDER LOAD	6" SPOOL AVERAGE PERM. SET.	PULL TO GET DEFLECTION	WEIGHT
WOOD METAL	.031	0.006	52.7#	19 oz.
ALUMINUM DRAWN	.012	0.001	108#	19 oz.
ALUMINUM BRAZED	.013	0.001	104#	17 oz.
ALUMINUM DIE CAST TWO HALVES	.012	0.000	98.4#	24 oz.
MAGNESIUM DIE CAST ONE PIECE	.007	0.000	122.5#	19 oz.
THERMO PLASTIC BODY & PLUG	.059	0.003	94.4#	13 oz.
FIBRE GLAS BODY & PLUG NO CLAY	0.023	0.000	133.4#	15½ oz.

THERMO-PLASTIC SPOOL

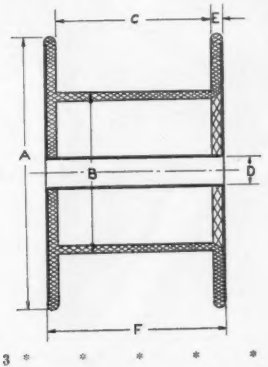

Figure 3

2 BIG NEWS FEATURES

New Carboloy Heading Hammer, with markings, and Carboloy Flat Wire Rolls bring amazing benefits to users. Here's how they can help you.

1 New Carboloy nibs hammer the mark over 1,000,000 times!

That's real news!

Carboloy's new heading hammers, *now furnished with markings*, have turned out 900,000 cap screws to date for a midwest manufacturer, and are still running without noticeable wear. Original 1,000,000 estimate for Carboloy nib life has been revised to 2,000,000, as compared to 100,000 limit with steel hammers.

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Send in the coupon on opposite page to find out how you can get the savings these Carboloy heading hammers bring.

2 Carboloy flat rolls cut setup time 75%!.. spot change down time 97%!

More good news!

Carboloy flat wire rolls bring longer roll life, increased production and lowered manufacturing costs to your mill operations. Just take a look at what they have done in a large eastern rolling mill:

- ★ **Operated over 1 year, 24 hours per day, 5 days per week—without any need for regrinding!**
- ★ **Setup time cut 75%—from two hours every month with steel, to two hours every six months with Carboloy.**
- ★ **Spot change down time cut 97%—from twice a week with steel to once every six months with Carboloy.**
- ★ **Better finish on end product, with definite savings through more uniform wire.**

Similar savings, right down the line, can be yours. If you roll either high or low carbon steel wire, it will pay you to find out all about Carboloy flat wire rolls. A coupon request (it's on the opposite page) will bring you complete information.

...and here's more important news about Carboloy — and Carboloy dies — that's good news for you!

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1 **Complete local stocks.** Strategically located sales and service branches insure double-quick delivery—save valuable time, meet tight production schedules.

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- A copy of your Carboloy Die Service Manual D-119 (useful information on die servicing and application) ☐

Name_____

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Position_____

ALUMINUM DIE CAST SPOOL

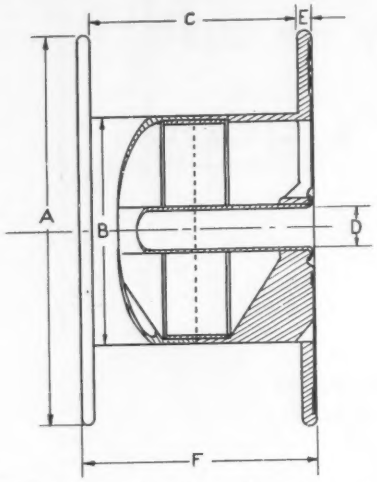

Figure 4

ANOTHER characteristic of a spool that a mill man desires very much is durability and dimensional stability. If the spool is designed with a material that requires frequent maintenance to repair the defects that arise from rough handling in shipping, the spool soon becomes a liability on the inventory rather than an asset paying dividends on the investment. Some examples of this would be bending of the heads thus reducing the traverse or nicking of the edges of the spool, and also bringing up burrs which would catch and snag the fine wires. In one case that is known one mill pays approximately ten cents every time a spool must be straightened. This is based only on labor costs and does not include loss of overhead.

★ ★ ★

THE trend in present day wire spooling is towards the finer wire on larger spools. In the past where a crack between head and hub of 0.026″ was permissable, today there must be no crack so that the fine wire 0.003″ diameter is not trapped. If this fine wire were to become trapped it would build up in the crack and eventually render the spool worthless, let alone causing poor production during the building up process. In order to eliminate this possible fault in a spool, the manufacturer had to design—at slightly greater costs—a spool having no possible place of entrapment. The trend has been from two joints on the working surface to one joint and then finally to none. The last step, of course, is the ideal one.

★ ★ ★

IN addition to all of the above mentioned points a good spool should have many other features. Good stacking characteristics, provisions for lug holes, wire holes and label holders, wear resistant surfaces and good eye appeal are a few among the main others that all people want. Eye appeal is especially important to the sales department of the wire mill. The salesman of any one wire company is offering essentially the same wire according to certain specifications as any other salesman from other mills. He must have an added

MAGNESIUM DIE CAST SPOOL

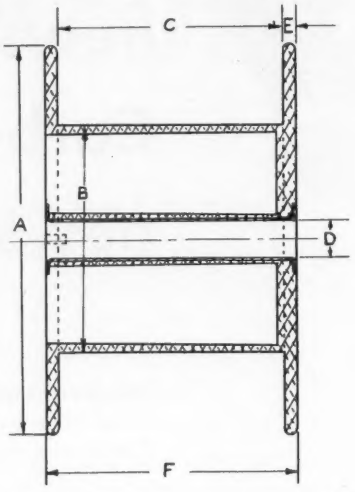

Figure 5

attraction to help sell his product and if he can present his wares on a better looking spool he can gain a psychological advantage of attractive packaging.

★ ★ ★

NOW that all the factors that contribute toward the design and production of a spool to ship magnet wire have been considered it is best to review Table III where comparative evaluations are given for the seven different types of spools studied. In studying this table it is best to take each spool separately and read across the columns.

(*Please turn to page* 973)

TABLE III

TYPE SPOOL	CONCENTRICITY ACCURACY	COST	STRENGTH	WEIGHT OUNCES	APPEARANCE	DURABILITY	CONTINUITY OF SURFACE	DIMENSIONAL STABILITY
Wood Metal	Poor	Low	Poor	19	Poor	Very Good	Poor	Very Good
Two Piece Alum. Die Cast	Good	Med-High	Very Good	24	Good	Poor	Very Good	Very Good
One Piece Magnesium Die Cast	Good	Med-Low	Excellent	19	Fair	Fair	Excellent	Very Good
Sheet Alum. Drawn	Very Good	High	Very Good	19	Very Good	Poor	Very Good	Poor
Sheet Alum. Drawn Brazed Heat Treated	Very Good	High	Very Good	17	Very Good	Fair	Excellent	Fair
1 Piece-Plug Thermoplastic	Excellent	Low	Poor	13	Excellent	Very Good	Excellent	Subject to cold flow
1 Piece-Plug Fibre Glas	Excellent	Medium	Good	17	Excellent	Excellent	Excellent	Excellent

Plastic Strain and Hysteresis in Drawn Steel Wire

By R. S. Brown, M.B.E., F.I.M.

Rylands Brothers, Ltd., Warrington, England

SYNOPSIS

Forms of test applicable to wire are briefly reviewed and it is suggested that none of the tests normally applied can be used to assess the properties of wire required to withstand dynamic stresses. Considerable importance is attached to stress/strain characteristics at loads up to 75% of the ultimate tensile strength, and curves involving high magnification of strain are shown, in which important changes in plastic properties exhibited by drawn wire when subjected to static and cyclic loads and after passing round pulleys, are discussed in relation to the behaviour of colliery winding ropes. The effect of temperature during wire-drawing is examined and some comments are made relating to the behaviour of heat-treated wires when subjected to combined bending and dynamic stresses.

DESPITE much published work relating to the mechanical properties of drawn steel wire, considerable confusion and misconception still exists among engineers and users of wire regarding the elastic and plastic properties of this cold-worked material. Information on this subject is widely scattered, and for this reason the significance of these fundamental properties has not been sufficiently appreciated in relation to the behaviour of wire under conditions of nearly static loading, as in stay wires, for example, or under conditions of cyclic tensile stresses combined with bending, as in wire ropes.

* * *

IT is customary to determine the suitability of wire for wire ropes and other purposes by means of torsion and bend tests. No attempt has yet been made to correlate the results of these tests with the behaviour of the wire in service, but it is clear that none of the tests normally applied can be used to predict its life under any given condition.

* * *

STEEL wire is probably the only form of metal used in engineering practice which is required to be bent repeatedly under conditions of high initial stress, and it is suggested that it is due to the peculiar properties associated with cold-worked steel that it is able to withstand these arduous conditions.

* * *

IN this paper an attempt has been made to assemble current data, together with the results of investigations made by the author over the past few years, and at the same time to illustrate how stress/strain properties affect the performance of wire used for ropes and other purposes.

* * *

Tests Normally Applied to Wire

IN the first place it is desirable to review current methods of testing wire and to show how they fail to provide useful information relating to fundamental properties which influence performance in service. It is perhaps true that the existing testing procedure will detect wire suffering from gross defect but it will give no information on the usefulness of wire for a given purpose.

* * *

Tensile Test

THE tensile test can be nothing more than a standard of reference. As applied to severely drawn wires, values of breaking load convey little useful information in the absence of more precise knowledge of strain characteristics. For example, a wire manufacturer may be asked to supply both spring wire and rope wire, which are manufactured under quite different conditions so as to induce properties required for these widely diverse purposes. The maximum tensile stresses may be identical and thus cannot convey any information of the true properties of the two wires.

* * *

Torsion Test

IN the torsion test one end of the wire is gripped and the other end is rotated until fracture occurs, one of the grips being capable of axial movement to allow for change of length of the specimen during the test. The number of twists is usually proportional to the length of the wire and the test is standardized on a gauge length of 100 diameters. This test is of historic interest and has become firmly established in the wire industry in this country, where it enjoys a popularity not accorded to it on the Continent. It is difficult to see what precise property of drawn wire it defines, although it has considerable value when used qualitatively for the detection of surface flaws. In the past high numerical values obtained in this test reflected in some measure that extreme degree of fibrousness induced by grain enlargement during the air-patenting heat-treatment followed by the very severe cold work performed in order to achieve the high tensile strengths required for many purposes. Much wire produced in this way was demonstrably brittle despite very high numerical values of twists, and for this reason the torsion

Paper MW/D/66/47 of the Drawing Committee of the Mechanical Working Division of the British Iron and Steel Research Association, received 10th September, 1948. The views expressed are the author's, and are not necessarily endorsed by the Committee as a body.

Another Firth Sterling FIRST

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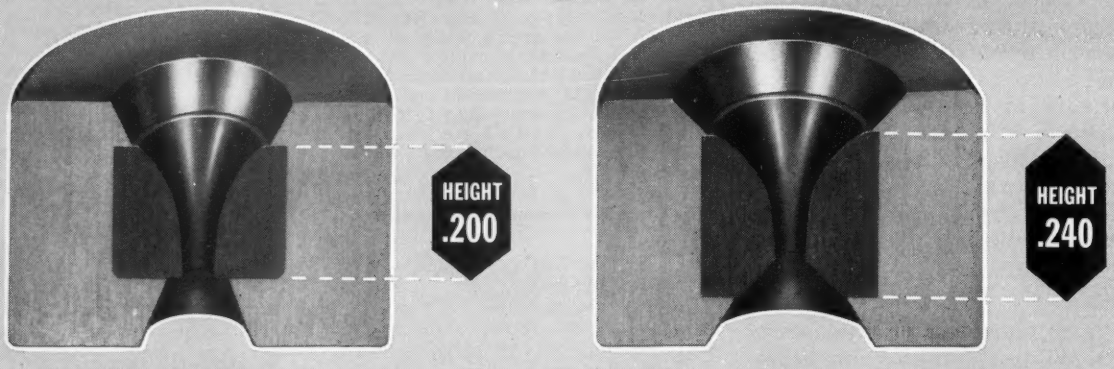

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test must be viewed with a more critical eye if progress is to be made in the production of wire having a high resistance to fatigue failure.

★ ★ ★

Reverse Bend Test

THE reverse bend test has not been properly standardized in this country, although on the Continent, where much importance is attached to it, bend testing machines possessing excellent characteristics are available. The test is useful in assessing freedom from brittleness in drawn steel wire, and when properly applied it is a better criterion for rope wire than are other tests at present in use; it must, however, be related to the conditions under which the wire is to be used, or undue importance may be attached to high numerical values.

★ ★ ★

Fatigue Test

ENDURANCE properties of wire determined on conventional machines have been shown to be affected to a greater degree by the condition of the wire surface than by modifications in method of wire production,[1] and in one case[2] at least, an attempt to assess the properties of wire for a particular purpose by this test has been most misleading. Fatigue breakdown in wire ropes in service rarely occurs at the original wire surface, and wire failures are more usually associated with wear, when fracture of cold-worked films initiates failure, or with corrosion, which is known to accelerate the development of fatigue cracks. For this reason the use of fatigue testing machines has proved disappointing, and approach to the problem of increasing the endurance of wires must be made by other methods.

★ ★ ★

Elongation at Fracture

WHATEVER value may be ascribed to the elongation at fracture as a test for rigid engineering members, it has little or no significance when applied to wire. Exceptions may be made in the case of mild-steel wires required to undergo severe plastic deformation, as in the manufacture of cold-forged bolts, or in the case of mild steel wires that are to be severely bent round small radii for forming operations.

★ ★ ★

THE high elongation at fracture possessed by a hot-rolled or heat-treated rod before wire-drawing is rapidly destroyed with increasing degrees of cold work, so that hard-drawn wires such as rope wires and spring wires possess little residual elongation, and most of this is due to necking-down at the moment of fracture. The total amount of elongation at fracture can be trebled by simple heat-treatment at low temperature, for example in hot-galvanizing, but the quality of wire for all purposes is not necessarily improved thereby.

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Reduction of Area

THE foregoing tests are those generally applied to wire, but in some specifications a minimum reduction of area at fracture is required. This quantity is difficult to measure accurately on wires of small diameter and it is doubtful whether it reflects any useful property.

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Stress/Strain Tests

FOR some years stress/strain tests have been applied in the author's laboratory to define properties of wires for various applications, and particularly for wire ropes. The known lack of 'elasticity' always associated with drawn wire has long been regarded as significant, and a detailed investigation into the factors governing the magnitude of the plasticity of wires has proved to be of considerable value. This indirect attempt to assess endurance properties of wire has latterly been emphasized by some work on strain behaviour under conditions of cyclic stress.

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Methods of Determining Strain

THE conventional single-lever tensile machine is adequate for loading, provided that it is fitted with means for applying the load slowly and smoothly. During the past few years attention has been given elsewhere to the effect of different methods of loading on the shape and nature of the yield point, but as drawn wire does not exhibit the sudden plastic slip associated with yield we are not concerned with these issues.

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DEVICES for the measurement of extension are legion and most of them are useless for work on wire. In many cases the magnification provided is far too small and it is probably for this reason that the erroneous belief has so long prevailed that wire-drawing raises the elastic limit.

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TYPES of extensometers fall roughly into four groups:

(1) Mechanical lever multiplying devices.

(2) Autographic recording attachments to the testing machine.

(3) Optical magnification using a light beam.

(4) A combination of (1) and (3) in which the mechanical magnification is small (usually 2 : 1) and the movement is magnified by a microscope.

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MECHANICAL lever instruments suffer from severe limitation of magnification, although one or two special types have been developed which overcome some of the drawbacks of earlier extensometers.

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AUTOGRAPHIC recording attachments have slowly developed from the crude arrangements where the points of attachment for measuring the extension were located on the grip heads, to later types where the extension is measured from the test-piece. The extension was usually transmitted to the recording device by strings or tapes whose elastic properties and variation in length with changes in temperature and humidity vitiated the results of high-magnification work. Consequently the magnification was insufficient and the short time employed in producing the curve masked the plastic and

creep* effects observable by more refined methods. It is interesting to note that a curve-tracing device which seems to overcome these disadvantages by the use of a synchronized-motor-driven micrometer has recently been developed in America. Fine-wire resistance strain-gauges have not yet been applied to wire specimens, but this method possesses obvious advantages, particularly in connection with investigation of the effect of cyclic stresses.

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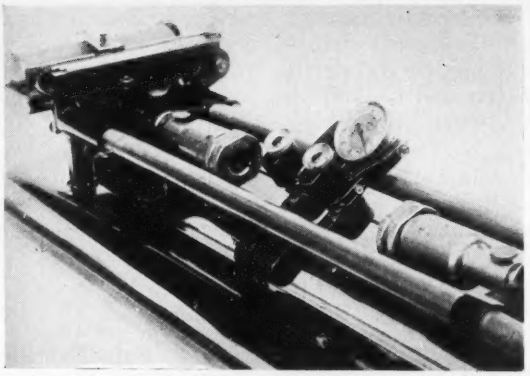

Fig. 1—Tensometer testing machine and Lindley dial-gauge extensometer.

OPTICAL instruments of the Martens type are capable of measuring very small changes in extension with great accuracy, but difficulties are encountered in attaching the apparatus to the wire specimen.

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THE Ewing extensometer has been used for most of the work described in this paper. The difficulty of attachment has been overcome by fitting the instrument with very sharp and specially hardened pivot screws which are advanced just sufficiently into the specimen to support the instrument and then very slightly released before locking in position. With the normal gauge length of 8 in., readings of extension of 0.00002 in. are possible. In practice, an accuracy of 0.0002 in., or one-tenth of the sensitivity of the instrument, is all that is necessary. This extension is equal to a strain of 0.000025, and the significance of readings of this refinement can be judged by the fact that if a 2-in. dia. locked-coil winding rope 1000 yards in length and 12 in. lay is loaded so that the outer wires are subjected to a strain of this amount, the wires lengthen by 1.01 in. The question of whether this is an elastic or a permanent extension is a point of considerable importance in determining the life of the wires in service.

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FOR some of the later work the Lindley dial-gauge extensometer has been used. In this instrument the gauge length is fixed at 2 in., despite which the magnification is of a high order and gives readings of 0.0001 in. Special grips are provided with this instrument for use on wire specimens, but minute hardened steel points have been attached in the centre of the grooves for accurate location and positive attachment to the specimen. This modification has proved quite satisfactory. Figure 1 shows the extensometer attached to a Hounsfield machine; this arrangement has been found very suitable for stress/strain work on wire test-pieces.

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THE results can be plotted in several ways. The load/exten-

*The term 'creep' is used throughout the paper to denote increase of extension under load at ordinary atmospheric temperature. It differs from the creep experienced at elevated temperatures inasmuch as extension diminishes with time.

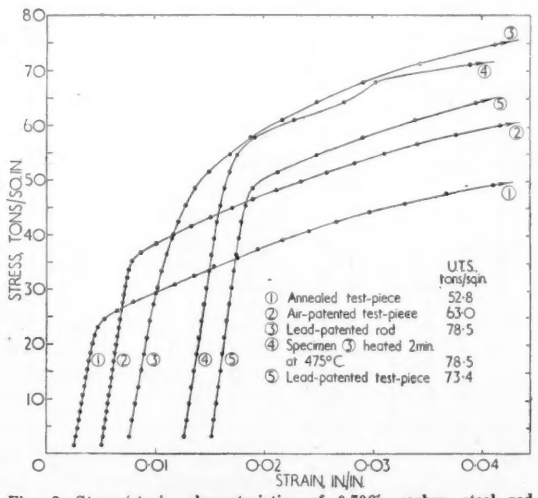

Fig. 2—Stress/strain characteristics of 0.70% carbon steel rod, 0.29 in. dia., showing changes due to patenting.

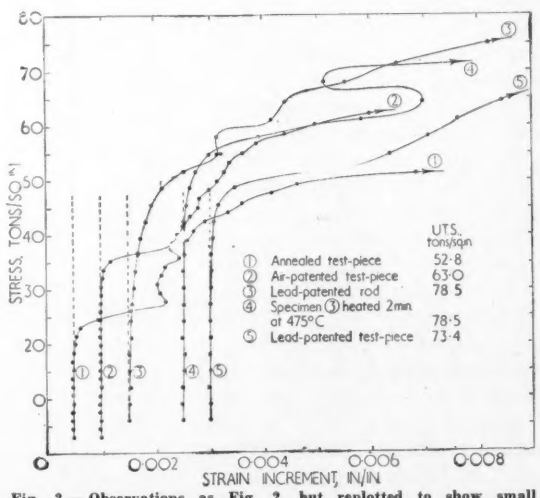

Fig. 3 — Observations as Fig. 2, but replotted to show small changes in strain.

sion diagram obtained by plotting increasing loading against extension of the specimen is not sufficiently informative and is likely to be misleading when comparing wires decreasing in size by increasing amounts of cold work. A better perspective is obtained by converting load and extension to stress and strain; but a third method, which is a modification of one described by Batson and Hyde,[5] consists of plotting differences between successive extension readings, and this yields curves of great refinement. If the specimen is elastic within the limits of sensitivity of the strain-measuring device, constant load increments will produce constant increments in extension. The difference between each successive extension will therefore be zero, within the limits of the elastic range, and will plot as a straight line parallel to the load ordinate. Indication of plastic strain is therefore shown by any deviation from the vertical. Figures 2-5 illustrate these observations, Figs. 3 and 5 being plotted on a strain-increment basis.

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Changes in Stress/Strain Properties During Processing

A SURVEY has been made of the effect on stress/strain properties of some of the variables encountered in the manufacture of wire of high tensile strength. Hot-rolled rods may be patented by cooling in lead or air, and the wire produced from these rods may be drawn by heavy or light reductions per pass, depending on the type of plant available; the total reduction of area may also be varied, depending upon the choice of analysis of the steel. These variations of practice cannot be without influence on the properties of the resultant product.

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Patented Rods

A LENGTH of steel rod of carbon content 0.70%, patented through lead, was removed from a coil for the following tests. To form a basis for comparison, a test-piece was cut to length, carefully straightened, and annealed by heating for 30 min. at 800° C. and cooling slowly in the furnace. Curve 1 of Fig. 2 shows the stress /strain characteristics, and in Fig. 3 the results have been re-plotted by the strain-increment method. The test-piece appears to be elastic over a range up to 20 tons/sq. in., and no clearly defined yield point is observable in Fig. 2. There is, however, some instability in the region of the yield point as shown by curve 1 in Fig. 3, which illustrates the sensitivity of this method of plotting.

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A SIMILAR straightened test-piece was air-patented by heating for 20 sec. at 1050° C. and then cooling freely in air. The tensile strength was increased by 10 tons /sq. in. and the elastic limit by 11 tons/sq. in., as shown by curves 2 in Figs. 2 and 3. For comparison, a length of the coiled lead-patented rod was straightened and tested without further treatment, and the results are shown in curves 3 in Figs. 2 and 3. These curves have assumed a different form, the marked instability shown in the previous curves having almost vanished, and there is now no clearly defined elastic range. Although curve 3 in Fig. 2 suggests, without close observation, that the rod possesses some elasticity, the strain-increment method reveals a deviation from the vertical ordinate starting with the first loading.

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THE lack of an elastic range in the coiled rod was assumed to be due to the slight cold work involved in coiling the rod and straightening it again for testing. This assumption was confirmed by repeating the test after submitting the straightened test-piece to a stress-relieving treatment at 475° C. In Figs. 2 and 3, curves 4 show that elasticity has been restored by this treatment and the marked in-

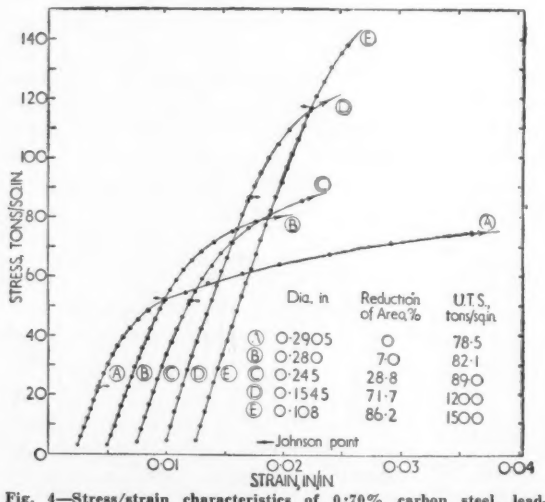

Fig. 4—Stress/strain characteristics of 0·70% carbon steel, lead-patented and drawn in stages to a total reduction of area of 86·2%.

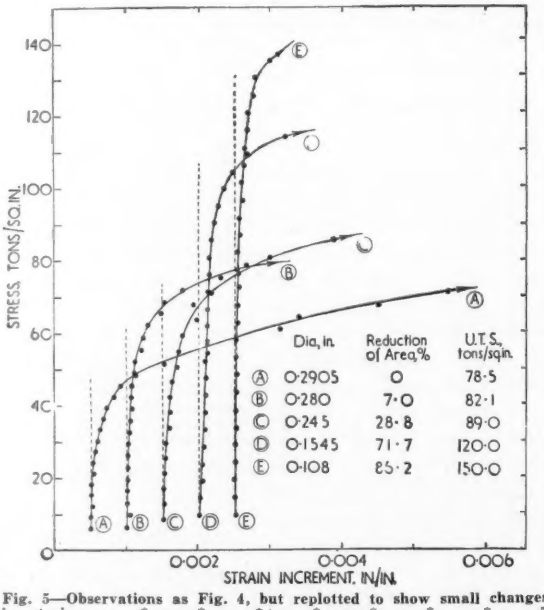

Fig. 5—Observations as Fig. 4, but replotted to show small changes in strain.

stability in the upper plastic region has returned. There is now an elastic limit at 35 tons/sq. in., although the point appears to be much higher in Fig. 2.

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TO confirm the plastic condition of a coiled rod, a straightened length from the coil was reheated to the patenting temperature and cooled in lead without disturbing its straightness. The test-piece heated in this manner was, however, slightly curved when cold, and it was necessary to manipulate it slightly for re-straightening. Curves 5 in Figs. 2 and 3 show a marked elastic range, but in Fig. 3 some slight plasticity is shown to have been induced even by the very small amount of work required to render the specimen perfectly straight.

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WHEN stripped from the coiling blocks, patented rods are therefore in a plastic condition due to the cold work involved in coiling round the drum, but subsequent baking, which is an essential part of the preparatory treatment for wire-drawing, will restore the elastic condition. Patenting is shown to increase the elastic limit and patenting through lead to yield a considerably higher tensile strength than patenting in air. The conventional yield point is suppressed, but there is a suggestion of plastic instability in the upper plastic range which becomes more marked after a stress-relieving treatment.

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Effect of Wire-Drawing

A COIL of lead-patented rod, from which the previous test-pieces were cut, was pickled, limed, and baked, and then drawn in a number of stages to yield a total reduction of area of 86%. Samples were selected at stages of 7%, 28%, and 71% reduction of area in drawing to compare the effects of light and heavy reductions. Stress /strain diagrams of these wires, together with that of the patented base, are shown in Fig. 4. That none of these samples is elastic can

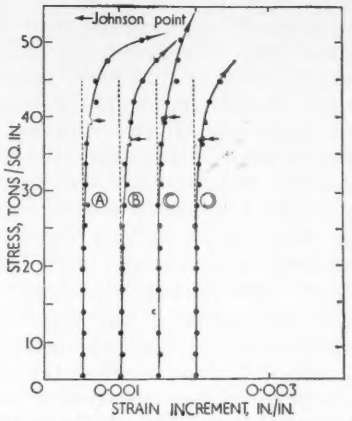

Fig. 6—0·40% carbon steel wire drawn 73% from salt-patented rod to 0·142 in. (U. T. S. 72·0 tons/sq. in.). (A) and (B) drawn 4 passes, (C) and (D) drawn 8 passes.

be seen by placing a straight-edge along the apparently straight portions of the curves. By replotting stress against strain increments, as shown in Fig. 5, the lack of elastic properties even in the patented base is clearly demonstrated.

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IN a paper dealing with wire ropes for mines by the Safety in Mines Research Board,[4] the statement is made that rope wire should not be incapable of undergoing further plastic deformation at low loads; with the possible exception of the curve **E** sample, it will be seen that this condition had been secured in the above test. While a high degree of plastic yield is necessary in the component wires of ropes, such a condition is undesirable, for example, in wires for springs or pre-stressed reinforced concrete. In these cases it is clear

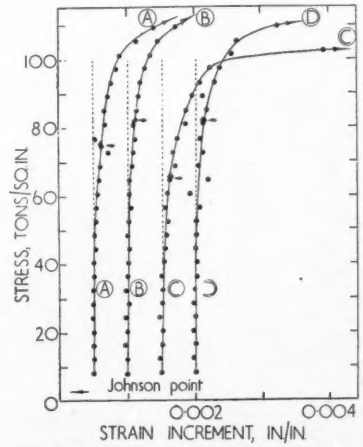

Fig. 7—0·118-in. dia. wire. (A) and (C) drawn 85% reduction, (B) and (D) drawn 75% reduction.

that perfect elasticity and a high elastic limit is required. The importance of stress/strain tests in assessing the usefulness of wire for different purposes is therefore emphasized.

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REFERENCE has already been made to curve **E** in Fig. 5, and it is interesting to note that the wire from which the test-sample was taken was purposely drawn with an excessive total reduction of area, and because of this its temperature at each pass was considerably higher than normal. The curve suggests that some strain age-hardening has taken place, and the resulting enhanced elasticity confirms the usefulness of this method of production for the manufacture of drawn patent steel spring wire. The influence of low-temperature ageing on the shape of the stress/strain curve is discussed in greater detail later, but it is of interest at this juncture to note the importance of temperature rise during wire-drawing in governing methods of production.

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SINTERED tungsten carbide dies have made possible continuous wire-drawing, and this has introduced the danger of excessive temperatures in the drawn wire due to cumulative heating from pass to pass. Water-cooled blocks and dies have, however, enabled the temperature rise to be controlled within the range of speeds and reductions of area normally employed. Before the advent of continuous wire-drawing, it was the practice to draw rope wire by a large number of passes with a small reduction of area at each pass; between passes the coils were hung on hooks and allowed to stand for periods of an hour or more during which time some cooling took place. At first sight this might suggest that there was an appreciation of the beneficial effect of limiting the temperature at which the wire was drawn, but the practice was governed entirely by the torsion test to which some steels are peculiarly sensitive in the severely drawn condition. It was generally believed that poor tor-

sions were obtained from heavy reductions and high speeds of drawing, but it is now well known that the cause of low torsion values was the temperature rise in the wires which took place with this method of production in the absence of adequate arrangements for cooling.

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IT is interesting to compare the stress/strain properties of wire produced by the old methods with similar wire produced on continuous machines. Curves **A** and **B** in Fig. 6 are taken from the front and back ends of a coil of wire drawn with a reduction of area of 73% in four passes on a water-cooled continuous machine. Curves **C** and **D** have been taken from a similar coil of wire drawn with the same reduction in eight separate passes, the coils being allowed to stand and cool between each pass. A close comparison of these curves shows that the effect of adequate cooling on the continuous machine has secured the production of wire with enhanced plastic properties, despite the four heavy reductions, as compared with the eight lighter reductions customary in the old single-block practice.

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FIGURE 7 shows the results obtained from a group of four wires produced for some experimental haulage ropes. Two patented bases were produced in sizes suitable for finishing to a tensile range of 110-120 tons/sq. in., one coil being lower in carbon than the other. The required total reductions were 70% and 85% respectively. These coils were split and one pair was given to a wire-drawer with instructions to produce the finished wire exactly as he would have done a few years ago. The other pair was drawn on five-hole water-cooled block machines. The wire-drawer used an eight-hole drafting for the 85% reduction and a five-hole drafting for the 70% piece so that the latter coil compares directly with the continuous machine-drawn coil. The resulting curves are shown as **A, B, C,** and **D,** in Fig. 7, and the Johnson[5] points* are marked for comparison. Sample **A** has been drawn 85% in five passes—an excessive reduction per pass—on water-cooled blocks, and **C** has been drawn 85% reduction in eight single passes, which has lowered the Johnson point. A difference in tensile strength has exaggerated this reduction. The actual figures are as follows:

	Max. Stress tons/sq. in.	Johnson Point Tons sq. in.	Percentage of Max. Stress
Five-hole continuous machine	122.6	75.0	61.5
Eight-hole ordinary blocks	112.4	65.0	58

DESPITE excessive reductions per pass on the water-cooled blocks, the Johnson point has been increased by only 3½% of the tensile range. The samples drawn 70%, **B** and **D,** are almost identical for five-hole continuous drawing and for five-hole single-block drawing, indicating complete control of temperature on the water-cooled blocks. It is surprising to find that the wire produced by a lower total reduction on the single blocks possesses a higher Johnson point than the wire drawn at eight passes, and 85% reduction of area, on the same blocks. As the shape of the curves depends largely on the (final) temperature of drawing, these two curves illustrate the variable nature of single-block drawing practice.

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Changes Due to Direct Stressing

IT has frequently been stated that when an annealed or normalized test-piece is stressed to a point beyond its elastic limit, a new elastic range is induced coinciding with the applied range of stress.

***In the absence of an elastic limit in drawn wire, Johnson has proposed a definition of the apparent elastic limit as the point on the stress/strain diagram at which the rate of deformation is 50% greater than it is at the origin.**

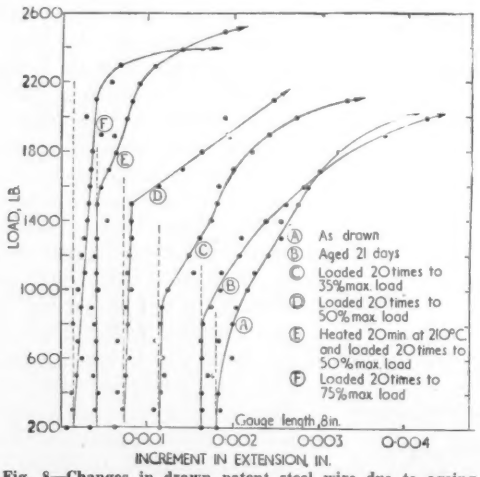

Fig. 8—Changes in drawn patent steel wire due to ageing heating, and repeated stressing. * * * *

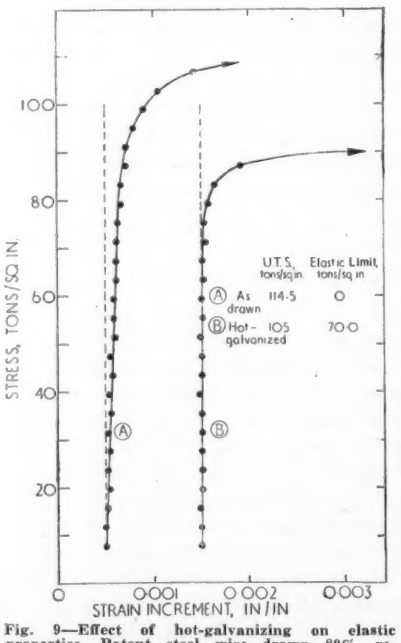

Fig. 9—Effect of hot-galvanizing on elastic properties. Patent steel wire drawn 80% reduction of area in five passes. * * *

It is doubtful whether true elasticity is obtained from one application of such a stress as some cold work has been performed. If a freshly drawn wire is stressed in tension its properties are even more profoundly modified. In order to demonstrate the changes in plastic and apparent elastic properties due to application of direct stresses, a number of load/extension diagrams have been prepared from wire subjected to the following treatments:

Sample	Treatment	Apparent Elastic Limit Tons/sq. in.	Percentage of U.T.S.
A	As drawn	0	0
B	Aged for 28 days	22.4	29.0
C	Loaded 20 times to 35% of U.T.S.	25.1	32.6
D	Loaded 20 times to 50% of U.T.S.	41.8	54.2
E	Heated to 210°C. for 20 min. and loaded 20 times to 50% of U.T.S.	42.5	55.0
F	Loaded 20 times to 75% of U.T.S.	58.6	79.3

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THE curves are shown in Fig. 8. They demonstrate that the elastic and plastic properties of drawn wire depend on the treatment given during subsequent usage. There is an apparent increase in elastic recovery with increasing stress, but, with the exception of sample **E**, which has been heated to 210° C., none of the samples is strictly elastic within the apparent elastic range. It is clear, therefore, that the repeated application of a direct stress improves, but does not perfectly restore, elastic properties in a drawn wire.

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Effect of Heat

THE release of internal stresses by heating drawn wire to low temperatures is so well known as to require little comment. Strain age-hardening is induced by heating in boiling water if sufficient time is allowed, and it proceeds with increasing velocity as the temperature of heat-treatment rises. At the galvanizing temperature the change is independent of time. Figure 9 shows complete recovery of elasticity after galvanizing a test-length without coiling or bending. Curve **A** is the drawn wire and curve **B** the hot galvanized wire.

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IT is significant that ropes produced from finally hot-galvanized wire are known to yield shorter lives under given conditions than ropes produced from bright-drawn wire of the same tensile strength. Other methods of applying protective coatings are now available which obviate this effect.

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Combined Bending and Loading

SO far only changes due to gradually applied static loads have been considered, but most ropes are used in a manner involving bending round pulleys, drums, etc., in addition to tensile loading. Conditions of bending under simple static loads are rarely met with and a cyclic system of stresses is usually set up. The effects of cyclic stresses are dealt with in the succeeding section, but it is convenient at this stage to examine the effects of bending a wire round a pulley of relatively large radius whilst it is subjected to a static load.

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A NUMBER of lengths of wire were pulled backwards and forwards over a pulley by attaching one end to a horizontal reciprocating device and applying a weight to the other end. The pulley had a diameter equivalent to 115 times that of the wire, and the load was equivalent to a tensile stress of 5 tons/sq. in. The wire had a maximum stress of 114.5 tons/sq. in., and the ratio of applied stress to maximum stress was therefore as 1 : 23. Each wire was passed backwards and forwards over the pulley 50 times while under this load, and test-lengths of the same wire were subjected to 20 repetitions of a stress equal to 75% of the maximum stress without bending. Some of these directly stressed wires were subsequently subjected to bending over the pulley.

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THE results are shown by curves **A** to **D** in Fig. 10. The stress/strain-increment curve of the drawn wire **A** is shown to have been modified by an increase in plasticity after 50 reverse bends over the pulley, as in curve **B.** In the test-length subjected to 20 direct loadings, elastic conditions are very nearly restored, as shown by curve **C,** but when these wires are subjected to bending round the pulley they return to the original

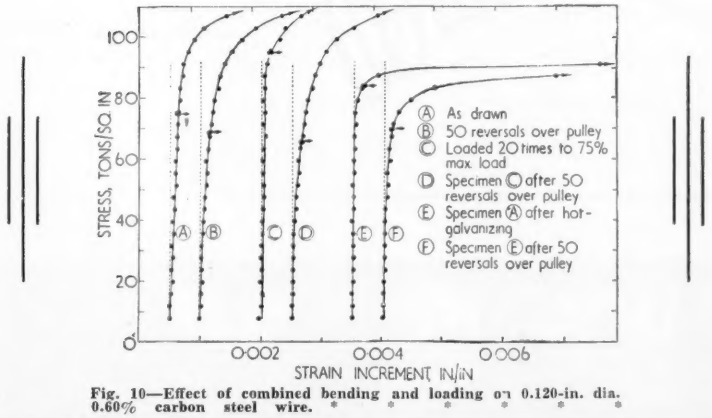

Fig. 10—Effect of combined bending and loading on 0.120-in. dia. 0.60% carbon steel wire.

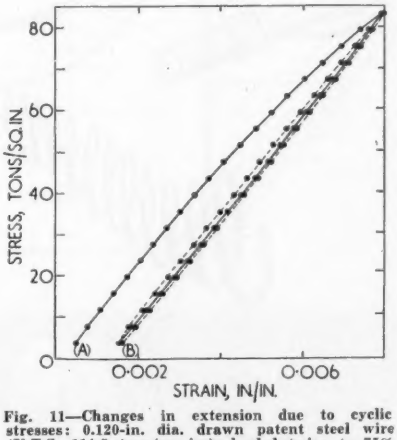

Fig. 11—Changes in extension due to cyclic stresses: 0.120-in. dia. drawn patent steel wire (U.T.S. 114.5 tons/sq. in.), loaded twice to 75% of U.T.S.

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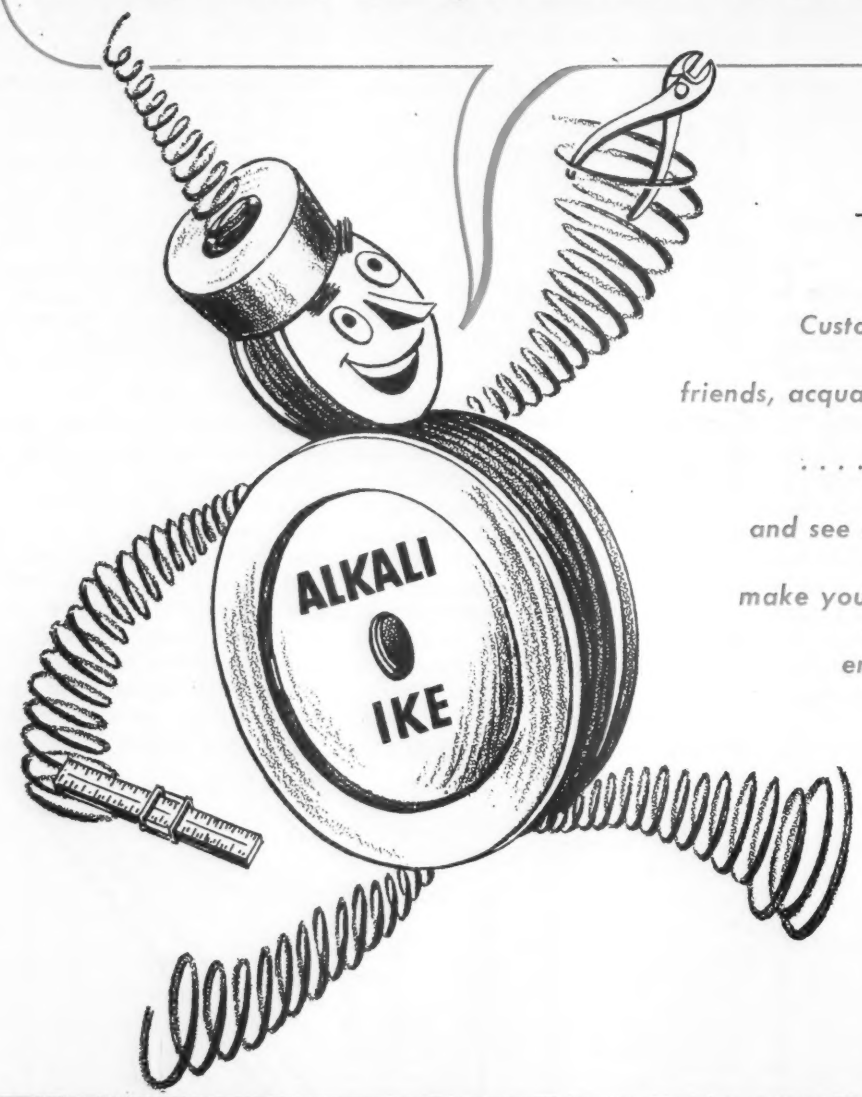

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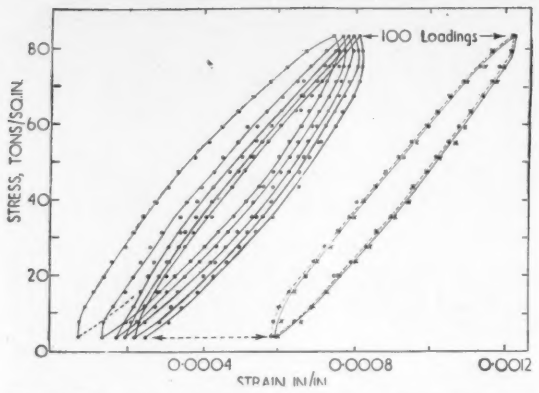

Fig. 12—Effect of repeated loading on 0.120-in. dia. drawn patent steel wire (first loading omitted).

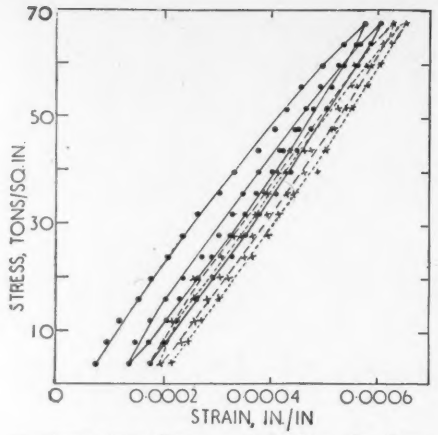

Fig. 13—Stress/strain diagrams of 0.120-in. dia. drawn patent steel wire, loaded and unloaded four times after heating for 30 min. at 250°C., showing reduction in hysteresis.

plastic conditions as shown by curve **D.**

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SIMILAR tests were carried out on a length of hot-galvanized wire. A straight length after galvanizing exhibited perfect elasticity as shown in curve **E.** It was then subjected to the bending treatment described in the previous paragraph, and, as shown in curve **F,** the elastic properties induced by the heat-treatment at the galvanizing temperature have been destroyed.

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THESE changes induced by bending or cold work are of great importance in connection with the behaviour of wires in wire ropes, particularly those used for colliery winding. Pre-formed methods of construction require severe cold work on the wires comprising the strands in order to form them into the lay of the rope. These wires lie dead, that is to say they show no tendency to untwist when the rope is cut; for this reason they must have been rendered more plastic by bending into shape, and it is probable that some of the improvement in the life of preformed ropes is due to this cause.

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Cyclic Stresses

THE preceding experiments have dealt with the effects of direct loading and with combined loading and bending. Few ropes are used purely in static tension; the great virtue of flexibility possessed by a wire rope enables it to be used over pulleys and drums, which are essential parts of any equipment used in raising and lowering loads.

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THE repeated loading and unloading of a rope involves cyclic stresses, i.e., stresses varying between an upper and lower limit. The frequency of the cycle may be low, as in the case of crane ropes, or high, as in the case of a winding rope subjected to shocks at decking. In a smooth wind the load may be taken up rapidly, maintained for nearly a minute, and then released sharply. During these operations the wires are subjected to bending stresses and these cyclic or dynamic stresses affect the physical properties of the wires in the rope. The changes in strain during these repeated loadings and unloadings are of fundamental importance and they yield a clue to the unique endurance properties of drawn wire.

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FIGURE 11 shows the changes in extension when a test-specimen of high-tensile-strength wire is subjected to two loadings and un-

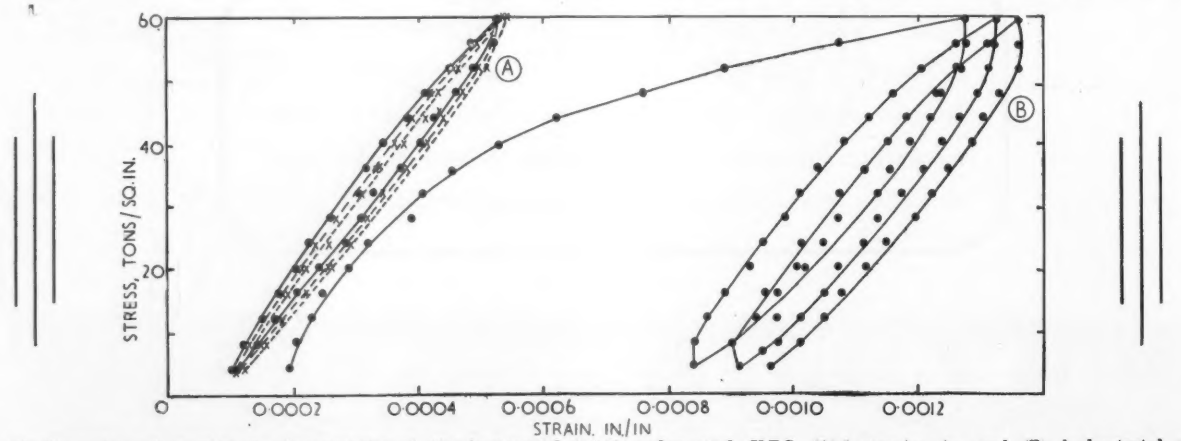

Fig. 14—Comparison of stress/strain characteristics of (A) heat-treated 0.60% carbon steel, U.T.S. 100.5 tons/sq. in., and (B) lead-patented and drawn steel wire, 0.50% carbon, and U.T.S. 100.8 tons/sq. in., loaded three times to 60% of U.T.S.

loadings to 75% of its maximum stress. Its initial high plasticity is indicated by the permanent set of 0.001 in. per inch of gauge length at (a) and (b). The second loading and unloading, shown dotted, fails to follow the track of the first removal of the load, and tends to form a loop, which is characteristic of hysteresis phenomena.

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IN order to see more clearly the plastic-strain behaviour under these conditions of cyclic stress, it is necessary to plot the strain component to a larger magnification. Simple increase in the strain scale introduces difficulties of presentation, and in Fig. 12 the magnitude of the loops has been increased to a scale ten times greater than that normally adopted, retaining the general slope of the curves on the original basis. In this figure the first large permanent set has been omitted and four succeeding cyclic loops showing changes of strain with successive loadings to 75% of the maximum stress are plotted. At each successive load the wire undergoes a permanent set as a result of creep.

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EXPERIMENTAL work has been carried out which suggests that creep and hysteresis revealed by drawn wire are not permanent properties but tend to diminish with repeated loadings. The extent to which this occurs after 100 cyclic loadings is shown by the second curve in Fig. 12. In this curve the amount of creep has become very small at each cycle, only two of which have been plotted, and there is now a tendency for the formation of a closed cyclic loop. Hysteresis and creep properties are also markedly affected by tempering (blueing) as shown by the curves in Fig. 13. The very large initial permanent set has disappeared and there is a falling away in creep for each of four successive loadings. The marked reduction in the width of the hysteresis loop is also of considerable significance in connection with the known increase of stiffness in wires treated in this manner.

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DURING the course of this investigation, there was some speculation regarding the hysteresis behaviour of an approximately elastic wire. Specimens were prepared by quenching in oil and tempering back to a tensile strength equal to the drawn wire from which they were obtained. The first loops in Fig. 14 are the result of three loadings on one of these specimens. The amount of permanent set is extremely small at each loading, but there is some hysteresis. In the same figure are plotted identical loadings on the drawn wire, and the great difference in plasticity is very apparent.

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THE amount of this permanent set and the width of the hysteresis loop are therefore of the greatest importance, as it is these characteristics which permit a cold-worked wire to be bent severely without the skin stress rising to its breaking point. With increasing load, both the permanent set and the hysteresis loops increase in magnitude, and the wire therefore contains within itself the means of relieving severe overstresses which would cause rupture in a perfectly elastic body.

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Failures Due to Lack of Plasticity

Suspension-Bridge Wires

THE failure of conventional tests to determine the suitability of wires required to withstand dynamic stresses is shown somewhat dramatically by the now historic failure of the Mount Hope Suspension Bridge, erected between Bristol and Portsmouth, R.I., some 20 years ago. Several months after the cable had been spun, but before the bridge had been completed, fractures were discovered in the wires where the cables had been bent round the shoes of the anchorages. During a period of six weeks after the discovery of these fractures, further wires broke, the number increasing to such an extent that it became necessary to dismantle the partially completed bridge in order to prevent its collapse.

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THE wire used for the manufacture of these cables differed radically from that normally employed, as the high-tensile strength requirements were met by heat-treatment, hardening in oil, and tempering, being followed by galvanizing through molten spelter. Before embarking on this novel method of production, careful fatigue tests had been carried out in comparison with drawn wires of similar tensile strength, and as no significant difference in fatigue properties was observed, some confidence was placed in the departure from normal practice. The curves shown in Fig. 14 illustrate the great difference between the two types of wires, and the curves for the drawn wire must therefore represent a 'pattern' of cyclic stress/strain properties associated with high resistance to breakdown under combined stress.

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IT is possible to calculate the extreme fibre strain due to bending from the following formula:

$$E = \frac{d}{2}\left(\frac{1}{R_1} - \frac{1}{R_o}\right) \quad \text{.....(1)}$$

where E = strain at extreme fibres, inches per inch.
d = diameter of wires in inches.
R_1 = radius of mandrel, inches.
R_o = radius of curvature of wire before bending, inches.

For straight test-pieces, therefore:

$$E = \frac{d}{2}\left(\frac{1}{R_1} - \frac{1}{\infty}\right) = \frac{d}{2}\left(\frac{1}{R_1}\right) \quad \text{.....(2)}$$

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THE anchorage shoes of the Mount Hope Bridge had a radius of 9¾ in., round which was bent wire of 0.193 in. dia., a ratio of 50:1. An equivalent mandrel diameter for the wires shown in Fig. 14, 0.120 in. dia., would therefore be 6 in., and from equation (2) E=0.01 in.

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BY extrapolation it is seen that for a strain of this magnitude the stress at the skin of the heat-treated wire exceeds the maximum strength of the material, while for the drawn wire the skin stress is not greater than 60 tons/sq. in. for the same degree of bending. Of greater significance is the effect of fluctuating superimposed

tensile stresses. For the drawn wire, each application of stress is accompanied by an increase of strain which effectively maintains a low stress concentration at the skin, whereas the heat-treated wire is subjected to the constant repetition of a stress far exceeding the maximum that the skin of the wire can withstand.

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Wire Strand for Use on Railway Signals

THE manufacture of wire for railway signals was, until 1943, governed by British Standards Specification 163, first issued in 1934 and revised in 1936. The essence of this specification was a minimum elongation of 12% for the 40-50 tons/sq. in. tensile range. This necessitated the use of a medium carbon steel in the normalized condition. In addition the specification called for a torsion of 25 twists in a length of 100 diameters.

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DURING the period in which this specification was applied, a considerable number of failures occurred, nearly all of them at loops spliced on to the ends of the strands. A typical case is shown in Fig. 17 where most of the fractures are of a fatigue type, the remainder having broken in tension because of their inability to sustain the increased stress thrown upon them. This type of failure was so typical that considerable work in connection with fatigue properties was undertaken. Microscopic examination close to the fatigue fractures quite commonly revealed the presence of numerous creeping fatigue cracks, a typical example being shown in Fig. 18. In case the micro-structure shown should be misleading owing to its apparent cold-worked condition, it should be pointed out that the normalizing of wires prior to galvanizing is carried out continuously, using lead as a heating medium, the temperature rarely exceeding 730° C. At this temperature and with the high rate of travel through lead, the elongated pearlite of the drawn wire does not revert to its normal condition.

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FATIGUE tests of these normalized wires tend to be lower, although not markedly so, than wires of similar tensile strength in which the strength is obtained by cold work. A typical examination was made on two wires: No. 1 was drawn to the required tensile strength and finally hot galvanized, and No. 2 was drawn to size from a higher carbon steel and then normalized through molten lead at a temperature of 730° C. The results, which are as follows, show that there is a difference in tensile strength between the two wires, but the ratios of fatigue stress to ultimate stress are not markedly different; endurance curves obtained on the Haig-Robertson machine are shown in Fig. 15:

Analyses of Wires, %	No. 1	No. 2
Carbon	0.14	0.34
Silicon	0.121	0.144
Sulphur	0.038	0.033
Phosphorus	0.032	0.033
Manganese	0.45	0.75

Physical Properties	No. 1 (Drawn and Hot-Galvanized)	No. 2 (Drawn and Normalized)
U.T.S., tons/sq. in.	51.4	44.4
Elong. on 10 in., %	6.65	12.25
Torsions in 100 dias.	17	37
Bends over 5 mm.	12	23
Limiting fatigue stress, tons/sq. in.	22.0	19.7
Ratio of fatigue stress to ultimate stress	1 : 1.17	1 : 1.13

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SINCE fatigue tests taken in this manner yielded no clue to the unsatisfactory nature of the normalized material when subjected to fatigue conditions, the load/extension properties of the two types of wires were examined and the results fall into line with work previously described. In Fig. 16 are shown typical curves in which the marked elastic range of the normalized wire is in direct contrast with the plastic properties of the drawn wire. The high elongation of the normalized wire, to which in the past much importance has been attached, is shown to occur at a comparatively low load and obviously offers no safeguard against conditions of overstress. In this respect there is a close analogy between the heat-treated wires which failed on the Mount Hope Suspension Bridge.

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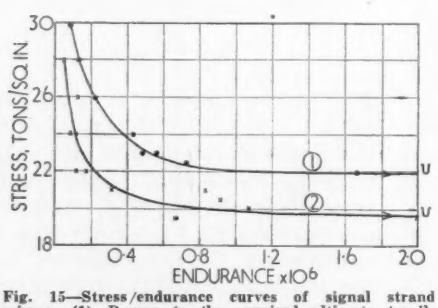

Fig. 15—Stress/endurance curves of signal strand wires: (1) Drawn to the required ultimate tensile strength, and (2) tensile properties obtained by heat-treatment.

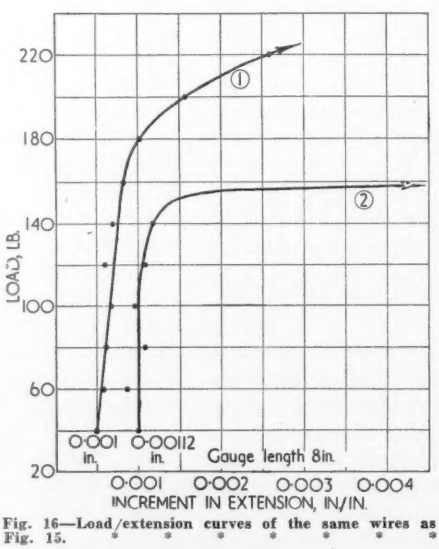

Fig. 16—Load/extension curves of the same wires as Fig. 15.

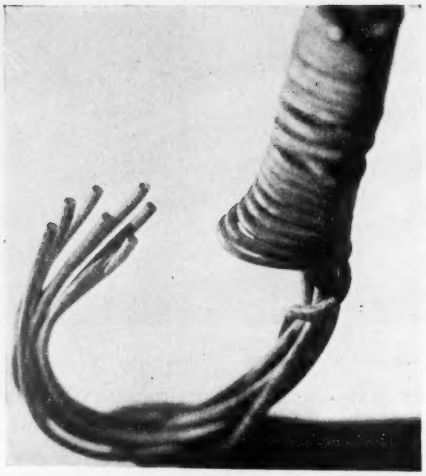

Fig. 17—Fractured signal strand loop, showing fatigue breaks.

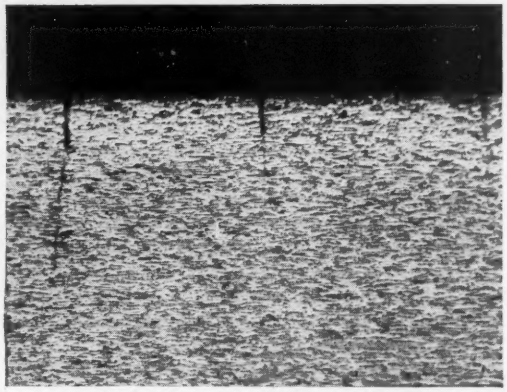

Fig. 18—Longitudinal section of the signal strand wire shown in Fig. 17, showing fatigue cracks close to fracture.

EVENTUALLY, full-scale trials of signalling strand, manufactured from drawn wires, were carried out in conjunction with one of the main-line railways, a site being chosen where many failures of the type shown in Fig. 17 had occurred. After the lapse of some time it became evident that the drawn wires were standing up to the highly stressed conditions of this location and the strands were maintained in service for an indefinite time without any suggestion of fracture at the loops.

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IN view of this experience the British Standards Specification was revised and the revolutionary step was taken of imposing a maximum elongation in place of the previous minimum of much higher value, in order to ensure the supply of nothing but drawn wire for this purpose. In the revised specification the torsion test was eliminated as it apparently had served no useful purpose, but a bend test was offered in substitution. The essential figures from the two specifications are as follows, and Figs. 19 and 20 show the difference in microstructure of the two types of wire:

17-S.W.G. Galvanized Steel Wire for Signalling Strand		
	B.S.S. 163 —1936	B.S.S. 163 —1943
Designation	W.S.2.	W.S.2.R.
U.T.S., tons/sq. in.	40-50	50-60
Elong. on 10 in., %	12 (min.)	7 (max.)
Torsions in 100 dias.	25 (min.)	...
Bends over 5 mm.	...	15 (min.)

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IT is noteworthy that since this revision no single instance of fatigue failure of the type shown in Fig. 17 has been reported in strands containing wires produced to the new specification.

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Core Wires in Locked-Coil Winding Ropes

REGULATIONS require that colliery winding ropes shall be recapped every six months, a length of not less than 6 ft. being cut off on each occasion. Examination of the lengths cut off frequently shows evidence of serious deterioration due to fatigue failures, and this is particularly so in the case of locked-coil ropes, those from deep shafts apparently being most affected. A photograph of the 17-wire layer from one of these ropes is shown in Fig. 21; fatigue breaks unaccompanied by surface deterioration are clearly shown. In view of this rapid break-up at the extreme end of the rope, it has been argued that this portion of the rope is subjected to the most severe stresses. It is difficult to appreciate the force of this argu-

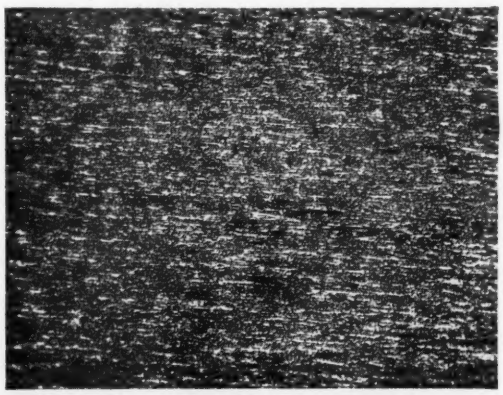

Fig. 19—Microstructure of heat-treated signal strand wire.

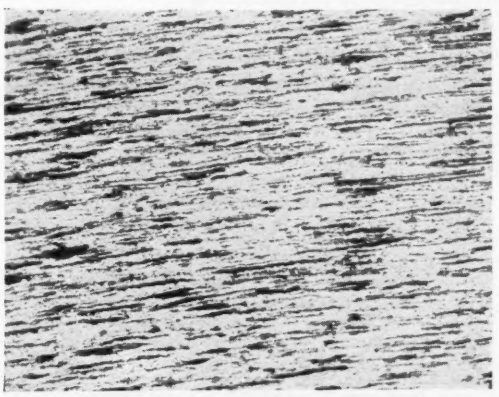

Fig. 20—Microstructure of hard-drawn mild-steel signal strand wire.

ment, particularly in the case of deep winds where the weight of the rope, together with the accelerating force, must impose a considerably greater stress in that portion of the rope immediately under the pulley when the cage is being picked up from the pit bottom.

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THE work described in this paper would suggest that there may be another explanation for the fatigue failures of wires at the free-end of these ropes. If curves **C** and **D** of Fig. 10 are examined in conjunction with the curves of repeated loading in Fig. 12, it will be seen that the repeated application of stress in direct tension destroys the property of plastic creep exhibited by a drawn wire and materially reduces the width of the hysteresis loop. If, however, the wire is subjected to further internal cold work by bending under tension, then the capacity for plastic creep is restored.

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FATIGUE failures of the type shown in Fig. 21 are less frequently met with in the length of the rope subjected to bending round the pulley and drum. As during this period the wires are being overstressed not only by bending but also by the direct stress set up by the accelerating force acting on the full length of the rope, it is somewhat surprising that this portion of the rope does not deteriorate more rapidly than the free end. Some significance must, therefore, be attached to the effect of bending in maintaining wires in a plastic condition. The free end of the rope, which is subjected to direct stresses only, can be expected to become elastic in service and in consequence liable to the type of fatigue normally discovered.

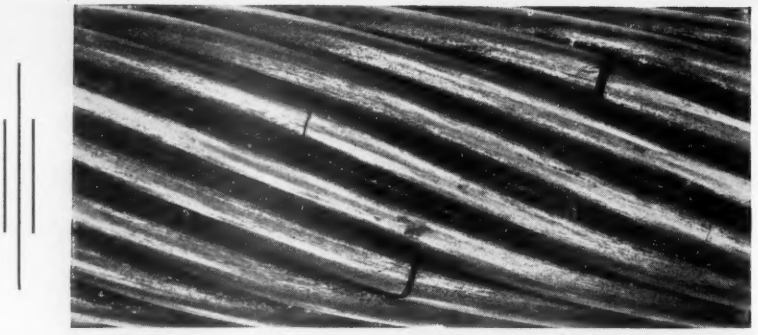

Fig. 21—Fatigue failures in the core of locked-coil winding rope. * * *

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UNFORTUNATELY it is impossible to obtain direct information of stress/strain characteristics from wires that have been stressed in service, owing to the fact that the manipulation required to straighten out the lay before testing completely modifies the stress-strain properties. It is, however, of interest to observe the behaviour of the heat-treated wire and of the cold-drawn wire of Fig. 14, when they are subjected to repeated bending while also under a direct stress. These wires were given 50 reversals over a pulley of a diameter equal to 115 times that of the wire, the load at the end being equal to a tensile stress of 4.5 tons/sq. in.

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THE results of three successive direct-stress cycles after this treatment are shown in Fig. 22. The heat-treated wire has taken on a slight permanent set and there is now evidence of creep at successive loadings. The marked plastic properties of the drawn wire have not been affected materially by this treatment, although there is a suggestion that the creep rate might fall off with further loading.

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IT is noteworthy that the method of production of wires for locked-coil ropes has, of recent years, been modified with a view to increasing plasticity, and there is some evidence that capel-end fractures are now not so prominent a feature as they were some years ago.

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IN Table I are given some values of hysteresis, permanent set, and rate of creep, for wires subjected to the various treatments outlined in this investigation. The reduction in both creep and hysteresis resulting from heating drawn wire at a low temperature is most significant, as this treatment is frequently used to induce stable properties in drawn wires after manufacture into springs

Table I

VALUES OF PERMANENT SET, HYSTERESIS, AND RATE OF CREEP AFTER VARIOUS TREATMENTS

No. 1 was loaded to 75%, and Nos. 2 to 6 to 60%, of the ultimate tensile strength

No.	Condition of Test-Piece	U.T.S. tons/sq. in.	Permanent Set at 1st Stress Cycle, in./in.	Hysteresis at 3rd Stress Cycle, in./in.	Rate of Creep at 3rd Stress Cycle, in./in.
1	0.60% carbon, as drawn	114.0	0.00105	0.000181	0.000038
2	Specimen heated for 30 min. at 250°C.	112.0	0.000062	0.000042	0.000018
3	0.60% carbon, oil-quenched and tempered	100.5	0.000010	0.000042	0.000008
4	Specimen 3, after 50 reverse bends round pulley	100.5	0.000073	0.000052	0.000011
5	0.50% carbon, as drawn	100.8	0.000645	0.00014	0.000049
6	Specimen 5, after 50 reverse bends round pulley	100.8	0.000678	0.00011	0.000025

and similar parts where permanent elastic properties are required.

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Wires for Pre-Stressed Reinforced Concrete

SHORTAGE of timber and steel for constructional purposes has led to important developments in the production of beams, railway sleepers, and similar parts in which severely drawn steel wires are incorporated. These wires are pre-stressed up to 70% or more of the ultimate tensile strength, and stable elastic properties are required in the wires if the strength of these concrete structures is not to deteriorate. Tentative specifications for the component wires have attempted to assess this condition on the basis of a proof stress, but at the outset difficulty has been experienced in defining a form of test suitable for use with freshly drawn wires.

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REFERENCE to Figs. 8 and 14 will show that proof-stress determination, particularly those involving permanent set when the load is released, are of little value owing to the change of properties effected by this treatment. As the tests recorded in Fig. 14 reveal, an imperfect elastic condition is conferred on a drawn wire by loading, the range becoming equal to the range of stress applied. Figure 12, however, shows that repetitions of stress of the order of one hundred are required before almost perfect elasticity is obtained. The work described also shows that complete elastic stability is obtained only by heat-treatment at a low temperature and that, should heating be preceded by loading, a true elastic limit equal to the applied load is induced.

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Conclusions

(1) Wire as-drawn possesses no elastic properties and therefore has no elastic limit.

(2) The unique ability of drawn wire to withstand the repeated application of combined bending and tensile stresses is shown to be due to its capacity for plastic creep associated with hysteresis behaviour of a high order. Wires of high tensile strength produced by hardening and tempering are shown to possess negligible creep characteristics and greatly reduced hysteresis. Such wires have proved to be unsuitable for use under conditions involving dynamic stresses.

(3) Simple ageing and accelerated ageing by heating to a low temperature restores the elastic range almost completely. Partial elastic stability is conferred on wires for use in pre-stressed reinforced concrete construction by the application of a high initial load, but more than one loading is necessary for complete stabilization to be effected. Attempts to assess the suitability of drawn wires used for this purpose by means of a proof test are misleading owing to changes in plastic properties introduced when the test-piece is loaded. If wires stabilized by either of these methods are bent round a pulley or otherwise manipulated, the elasticity conferred by the treatment is destroyed.

(4) Whether wire should be drawn by a small or a larger number of passes depends merely on the temperature developed by passage through the die and retained by the wire on the block. In the absence of special cooling arrangements a larger number of passes will produce a more plastic wire. The limit of speed in wire-drawing is therefore resolved into the question of how rapidly the heat generated in drawing can be abstracted from the wire, or in other words, the degree to which the temperature rise can be restricted. Consequently efficient cooling on intermediate blocks in continuous wire-drawing is of paramount importance.

(5) From these investigations the inference is drawn that:

(A) High plastic and hysteresis properties are essential for a durable rope wire.

(B) As these properties are impaired by rise in temperature of wire during drawing, future progress of the art must be along lines of complete suppression of temperature rise in the wire immediately as it leaves the drawing die.

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Acknowledgments

THE author would like to express his thanks to the Chair-

(*Please turn to page* 992)

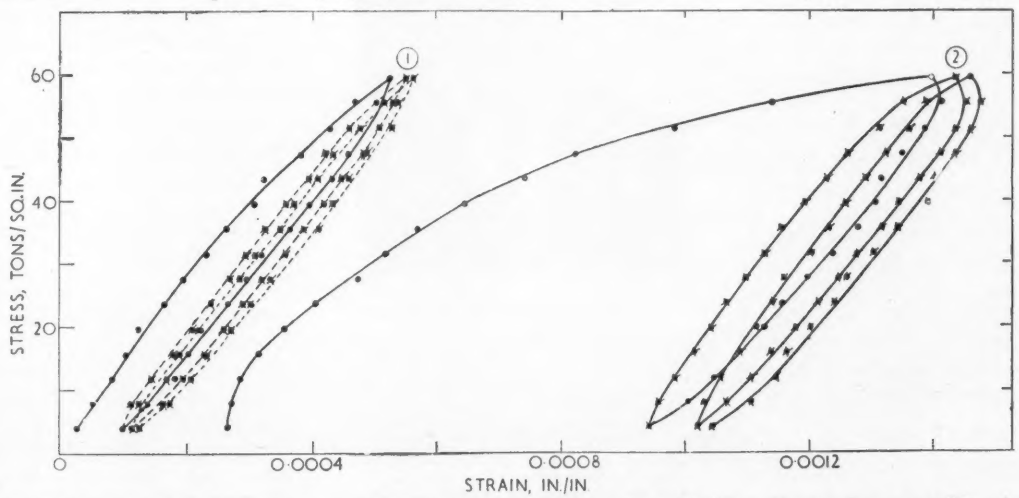

Fig. 22—Comparison of stress/strain characteristics of the same wires as Fig. 14, but after subjecting to 50 reversals over a pulley. * * *

Magnet Wire Plant - Fort Wayne Works General Electric Co.

By F. A. Arnold, Division Engineer

Wire and Insulation Division, General Electric Co., Fort Wayne, Ind.

A description of the processes and production methods used in the manufacture of magnet wire in the new Fort Wayne Plant of the General Electric Company.

OVER a period of years the **Fort Wayne Works** of the **General Electric Co.**, because of the location there, especially, of the Fractional Horsepower Motor Divisions and the Specialty Transformer and Ballast Divisions, has grown to become a very large consumer of magnet wire. Until the end of the war this growth had not been paralleled within the company by an ability to supply the increasing amounts that were being required. Consequently, at that time plans were begun to expand the already existing Fort Wayne wire facilities to the point where they would more nearly be in line with the Work's internal demand and, as well, the increasing demand of outside customers for Formex wire.

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AS there was no possibility of making such an expansion within the limits of the building then housing the Wire Division, it became necessary not only to add additional equipment but also to find new floor space. At about this time the company purchased from the War Assets Administration the building which during the war had housed the company operated turbo-supercharger plant. This building was a new one of single story construction having about 600,000 square feet of manufacturing floor space most of which had 40 x 50 feet bays with a ceiling height of 20 feet. There was a section, however, formerly housing the forge shop, which had 80 x 50 feet bays with a ceiling height of 40 feet, an ideal location for high enameling ovens.

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ACCORDINGLY, it was decided to use a part of this building for wire manufacture and to develop a layout in which the high bay area could be incorporated for an enameling room. The resulting floor plan, covering about 160,000 square feet, is shown on page 910.

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WITHIN this space there is capacity to produce round Formex wire, and glass, cotton, silk, etc. served round and rectangular wire to a total of about 900,000 pounds weekly. The Formex capacity comprises about eighty-five percent of the total and covers sizes from No. 40, American Wire Gage, up to and including No. 8, American Wire Gage. The served wire comprising the remaining fifteen percent is made in sizes up to about 90,000 square mils cross section.

F. A. ARNOLD

Mr. Arnold came to the General Electric Co. at Fort Wayne upon his graduation from Purdue University in 1925. Work in machine design assigned him to wire enameling equipment and processes at the initial installation of such equipment at that plant in 1931. During the war he was Supervisor of Mechanical Operations in the Turbo-Supercharger Plant, and upon its termination was made Assistant Superintendent of the Wire Division. In 1948 he was appointed Division Engineer, Wire & Insulation Division.

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ALL products start from hot rolled rod in the usual 250 pound coils which are purchased already pickled since no cleaning facilities have been provided. The rod is received from the vendors, both by truck and by rail, at fully enclosed freight docks located within the building along the north wall. Four freight cars and three truck trailers can be accommodated at one time. Unloading is done by electric industrial lift trucks with their usual forks replaced by a single ram which will hold about a dozen coils. These trucks move the rod to the storage area at the east end of the mill and there stack it in tiers up to three high. Each shipment is segregated and identified with an attached card showing the receiving date, car number, vendor, and the brand so that it can be readily located if the receiving inspection tests make necessary a further investigation of any particular lot.

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THIS storage area is the starting point of all manufacturing operations. From here the manufacturing flow progresses toward the other end of the floor, some 700 feet, in three roughly parallel lines. In considering them in detail it will be noticed that all transportation of material is by electric industrial trucks. Material handling in any wire plant is a major problem, and this one is no exception. All but an insignificant amount of the output is lifted and

moved at least six times during its processing, the equivalent of shifting at least 2,700 tons weekly. Because of this, as the plant layout was being developed, much thought was given to the use of various transportation methods such as continuously moving monorail chains, and powered and gravity conveyors. Four factors greatly influencing the final selection were:

1) **The necessity of maintaining a great degree of accessibility around most of the machines, especially the enameling equipment.**
2) **The great number of loading points per operator due to multiple spindle machines and multiple machine assignments.**
3) **The size and weight of the individual spool loads.**
4) **The difficulty of recognizing and separating almost identically appearing sizes and types of wire if they have been intermingled.**

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IT was finally decided that pallet handling of segregated sizes by fork truck would be the best solution. Accordingly one 2,000 pound ram truck and one 6,000 pound and three 4,000 pound fork trucks were provided for all handling involving transportation.

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BEGINNING, now, with the manufacturing lines, the first two are headed by five "break down" mills to start the drawing operations. All five are 13 die machines, three using 5/16" diameter rod, and two using ¼" diameter rod. Nearly all the 5/16" diameter rod eventually finishes into wire in the 'M', or medium range, that is wire from No. 24 to No. 14, American Wire Gage. The ¼" rod finishes into 'I', or intermediate range wire, that is from No. 31 through No. 25, American Wire Gage. The rod for these machines is stacked ahead of them in pits, two of which are in back of each machine. While the operator welds together the ends of successive coils and places them into one pit, the machine is emptying the other one. Wire drawn on the larger machines is spooled on 880 pound capacity reels, and that on the two smaller ones is spooled on 660 pound reels. The 2,000 pound ram equipped truck picks up these reels at the machines, carries them to a scale for weighing, and then delivers them to locations in back of the redrawing machines. These machines are arranged in two rows leading away from the breakdown mills. There are in one row three 13 die and nine 12 die machines for the 'M' range wire, and in the other row eighteen 16 die machines for the 'I' range wire. At the foot of these two rows are arranged twenty 16 die machines in which wire is redrawn down to sizes the smallest of which is No. 40, the smallest made in the plant.

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FROM all of these machines the output of drawn wire is stacked by the operators onto pallets to be trucked into the enameling rooms directly to the machines for which each size was scheduled. Most of the larger 'M' range wire is finished on 660 pound capacity reels, while the remainder of the range is finished on 220 pound reels. The 'I' range wire is finished on 80 pound reels. Overhead tramrail hoists are provided for stacking these reels onto the pallets. Inasmuch as there is considerable rolling and shifting of reels by hand within the entire drawing area, the wood block floor used elsewhere through the plant is here replaced by steel plate, both to eliminate gouging and scarring of the floor and to minimize handling effort. This involved the laying of some 15,000 square feet of floor plate.

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COMPOUND for the drawing machines is supplied from three separate systems centered in a basement near the head end of the lines. One system supplies the rod mills, another the 'I' range drawing machines, and a third the 'M' range machines. Each system consists of a twenty foot diameter, 14,000 gallon Dorr thickener tank emptying into a 2,000 gallon overflow tank from which the compound is pumped by a 700 gallon per minute centrifugal pump through under-floor piping to the machines. The compound returns to the thickener tanks in underfloor flumes. Thermostat controlled steam heating coils in the

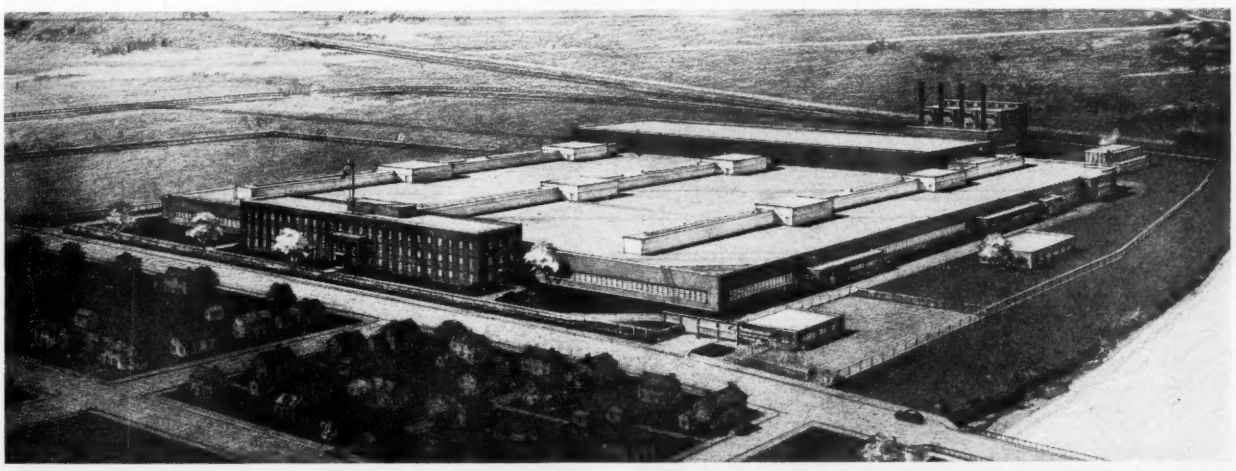

Figure 1—Taylor Street Plant, Fort Wayne Works of the General Electric Co. The magnet wire manufacturing facilities occupy the rear of this building including the high bay portion.

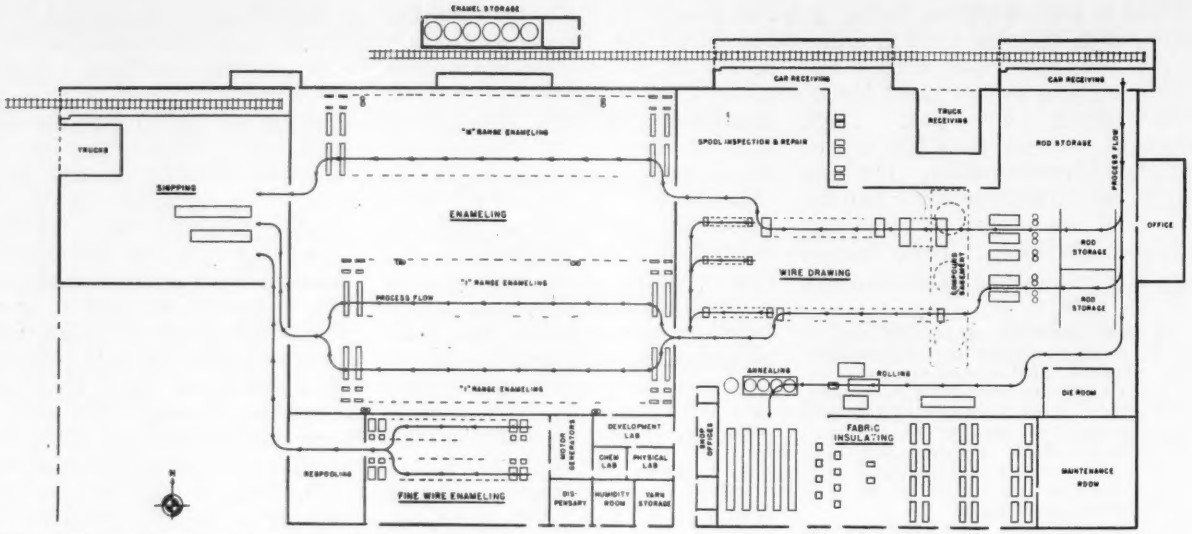

Figure 2—Schematic layout of the magnet wire plant showing the process flow.

overflow tanks supply heat when needed in starting, and heat exchangers of 254 square feet of surface in each system, using cooling tower water, can each extract heat up to 1,300,000 B.T.U.'s per hour if the systems' temperature rises too high. Makeup water is mainly boiler condensate although deionizing equipment is provided for standby use.

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ADJACENT to the wire drawing section, in the direction of process flow, is located the enameling section. This is divided into two areas walled off for air cleanliness and for ventilation control of enameling odors and heat. The larger of these areas is a space 200 by 250 feet in size having the forty foot ceiling height previously mentioned. In this are arranged three rows of enameling ovens.

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THE first of these rows contains nine 24 foot ovens having an overall height of 37 feet and fifteen 18 foot ovens having an overall height of 31 feet. These ovens, all of General Electric manufacture, are for enameling wire No. 24 and larger. Each can handle sixteen lines of wire through six coats. All are equipped with water washed scrubbers which, with allied equipment, recover from the oven fumes for reuse nearly all of the cresylic acid solvent in the wet enamel and also about thirty percent of the naphtha solvent. All ovens exhaust individually through the roof into horizontal headers of which there is one for each oven row. Each header ends in a steel stack which discharges to the air at 120 feet above ground in order to insure thorough dissipation of any fumes which could be objectionable at ground level.

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WIRE speed is controlled by Thy-mo-trol equipped D.C. motored capstans with tachometer generators to supply a signal that adjusts the armature voltage for holding constant any selected wire speed. The finished wire pick-up spindles, handling up to 16″ diameter spools, are individually D.C. motored gear reduction units powered from voltage regulated rectifier panels. Wire is supplied to these ovens from either 16″ x 11″, 220 pound capacity reels or 22″ x 11″, 660 pound capacity reels arranged in a supporting rack into which they are rolled to rotate with their axes horizontal. These racks support 18 KW ovens for

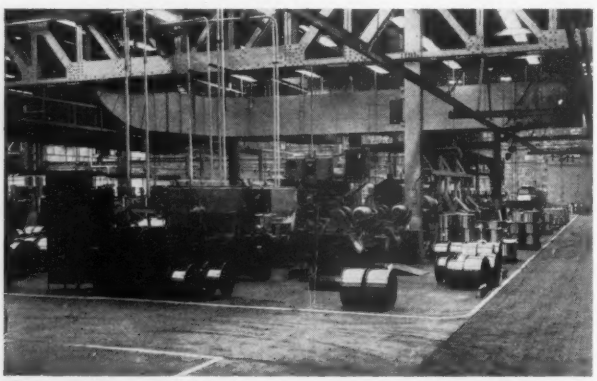

Figure 3—View westward along the north main aisle at the 'M' range drawing machines.

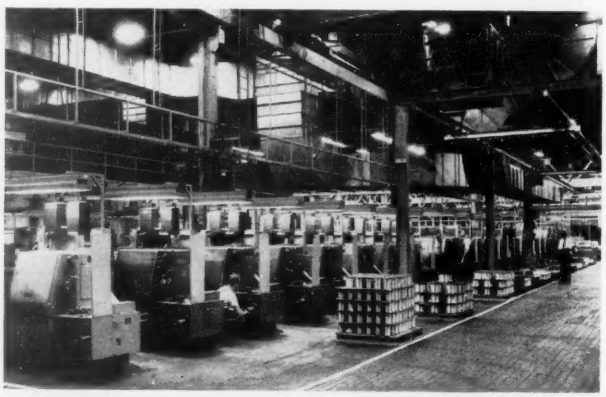

Figure 4—Looking east along the south main aisle at the 'F' range and 'I' range drawing machines.

preannealing the wire just before it enters the enameling ovens.

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IN the second and third oven lines are respectively twenty and twenty-five shorter ovens, also all of G.E. manufacture, for the handling of twenty lines each through six enamel coats. These are used for enameling wire in the 'I' range, that is from No. 31 through No. 25. As in the case of the larger ovens, these likewise are equipped with wire handling equipment having Thy-mo-trol powered speed controlling capstans. The pick-up spindles differ, however, in that they are A.C., ten cycle, 8 pole, torque motors with extension shafts for holding up to 8" diameter spools. Operating these motors on ten cycle current permits better tension regulation thru the empty to full spool range, and also limits the spindle free running speed to 150 RPM which permits easier handling when a wire breaks, a spool is changed, or some other cause releases the spindle load.

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BARE wire let-off equipment is similar to that for the larger ovens, but the spool sizes are smaller, the maximum being 12" x 6" with a capacity of about 80 pounds. Preannealing ovens mounted above these racks are of 12 K.W. capacity. Those in all three lines are supplied with controlled atmosphere from a central system battery of seven 1,000 cubic feet per hour General Electric atmosphere gas converters operating from natural gas.

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IN addition to the above ovens there are at the end of the second oven row four more, two of which are used for miscellaneous and odd lot Formex jobs and two as varnish treating towers for served wire.

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AT the back of all three rows of ovens are steel platforms or walkways for the convenience of operators in working at the top sheaves. To reach these platforms quickly and easily, two manlifts are provided in each row.

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IN order to prevent the temperature of the enameling room rising excessively high from the heat losses from so many large ovens, well distributed ventilation at the rate of seven complete air changes per hour is provided. Twenty-three roof ventilating fans spaced over the ceiling can exhaust 250,000 cubic feet per minute while three duct systems, totalling 290,000 cubic feet per minute, introduce fresh air which has been filtered through oiled screen belt automatic filters. There are eighty-five drops from the ducts, thirty-six being distributed over the floor and the remainder, one to an oven, coming down to the top working platforms at the wall rows of ovens. The difference in total fan capacities is intended to cause a slight pressurizing of the room and so prevent the introduction of other than filtered air.

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ARRANGED in the smaller enameling area or room are two rows of fifteen each of General Electric fine wire enameling machines each capable of handling sixteen lines through four coats. These consist of 9 K.W. horizontal ovens provided with wire handling equipment capable of taking finished wire spools up to 6" diameter. The pick-up spindles are A.C. torque motors. The regulating capstans are D.C. motored with power supplied by selenium rectifiers.

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ALL machines in both rooms have their water, inert gas, electric and enamel needs supplied through under-floor trenches. Housed in two basements are eleven enamel circulating systems each handling from ten to fifteen ovens. Each system consists of a 700 gallon tank from which enamel is pumped through a filter and a line heater to the ovens from whence it returns by gravity to the tank for recirculation. Automatic pressure, temperature, and tank level control equipment regulates these respective functions. Enamel to these tanks is supplied from six 10,000 gallon storage tanks housed just outside the main building and adjacent to the railroad siding on which shipments are received in tank car lots. Enamel usage is at the rate of two cars per week.

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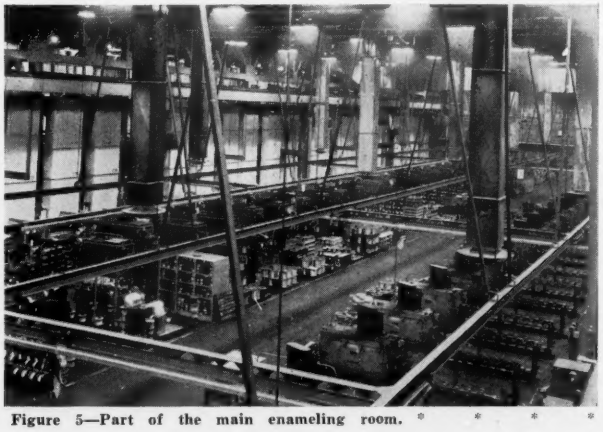
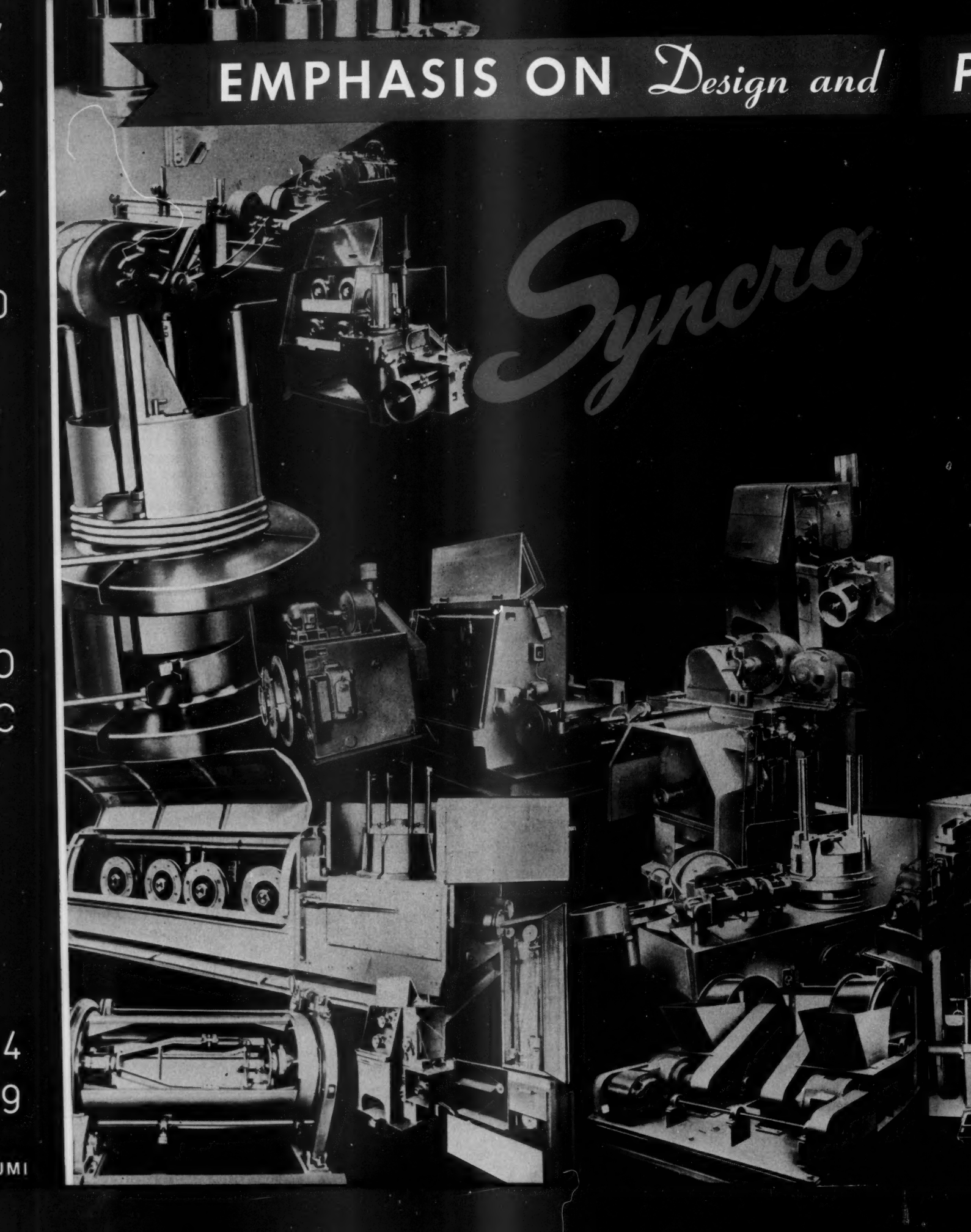


Figure 5—Part of the main enameling room.

Figure 6—'M' range enameling ovens. In the foreground are the supply racks holding 660 pound reels and supporting the pre-annealing ovens.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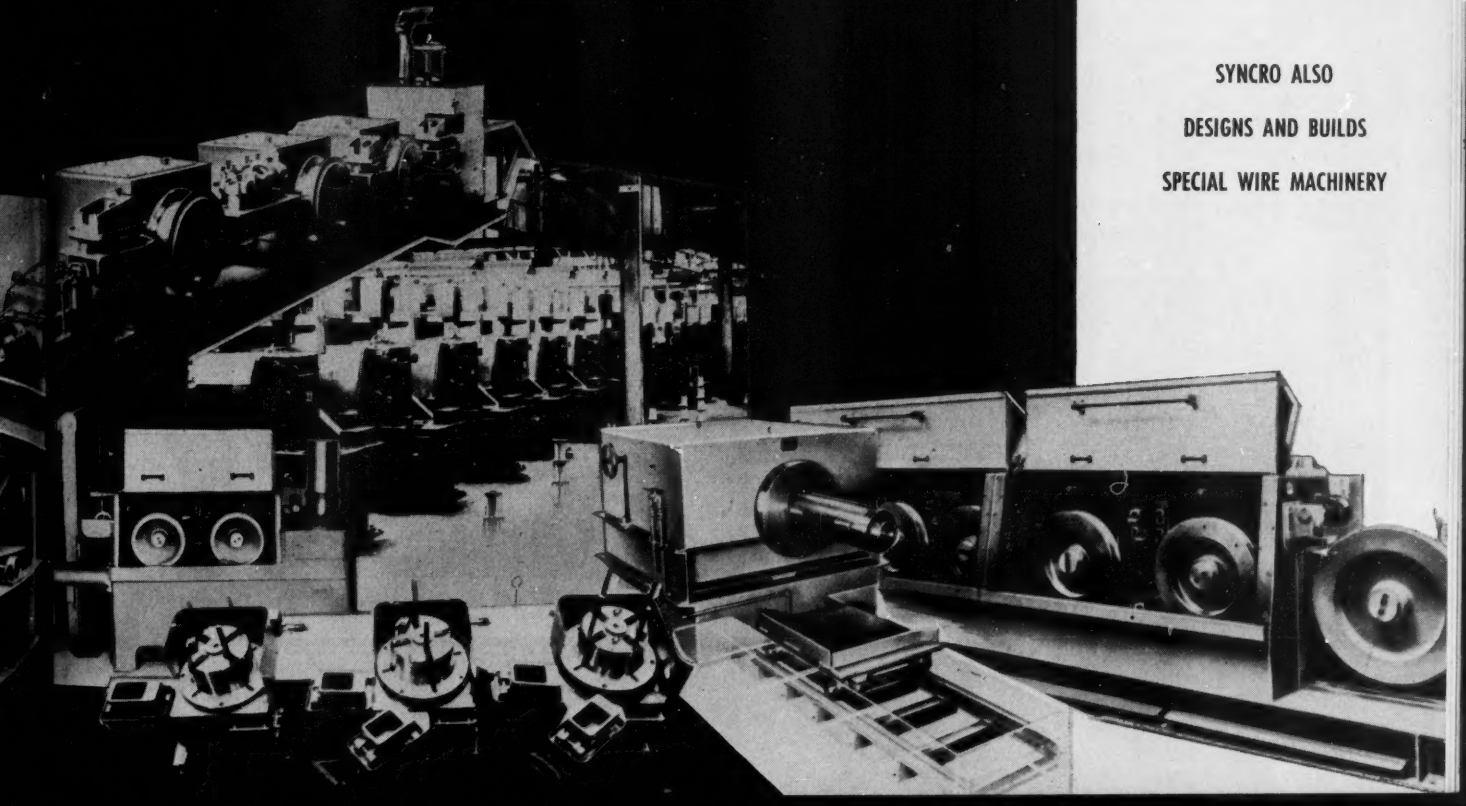

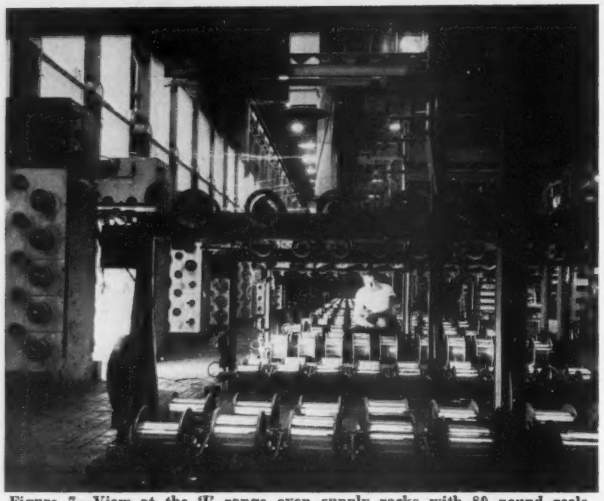

Figure 7—View at the 'I' range oven supply racks with 80 pound reels. The ovens with their capstans and pick up equipment are at the left.

Figure 8—View of the operating platforms at the rear of a row of 'I' range ovens. These platforms can be quickly reached from two manlifts, one of which can be seen at the right of the third oven. * *

ALL wire from the enameling machines is immediately stacked on pallets. That destined for shipment in large quantities to outlying plants of the Fort Wayne Works is placed on so-called shipping pallets with suitable in between spacers and the whole steel banded so that upon removal by fork truck to the shipping room it need only be weighed and tagged to be ready for shipment from the plant. A desirable feature of this method of shipping is that the empty spools with pallets and separators are returned in the same manner, thus protecting them and permitting easy handling and, if necessary, storing. All other wire, also on pallets, is also fork trucked to the shipping room, but there, if destined for outshipment, the loads must be broken down, weighed, wrapped and labeled individually. For this purpose two short conveyorized packing lines are set up. To eliminate much of the manual lifting in loading and unloading these lines, motorized lift platforms for pallet loads are provided at each end to bring the layers of spools to the conveyor height. For shipping, by either rail or truck, enclosed docks for two railroad cars and three trucks are provided within the building.

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PARALLELING these drawing and enameling machine lines is a third one, as mentioned before, in which 3/8" diameter and larger rod is first passed through a three block drawing and shaving machine and is then rolled into rectangular wire in one of three horizontal rolling mills or one vertical Turks-head machine. Since this wire, intended for glass and cotton serving, is then too hard for that purpose and must be annealed, there is a four base bell type annealing furnace with a 75 K.W. heater, all under a floor operated traveling crane. A 1,000 cubic foot per hour General Electric atmosphere gas converter provides the inert atmosphere required for bright annealing.

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THIS annealing furnace is adjacent to the fabric insulation section so that annealed wire, in spools of 250 pounds, can be hand rolled into a storage area ahead of the insulating machines. There are five horizontal two flyer glass serving machines equipped with ovens for varnish treating, and eight vertical two flyer machines for cotton covering, all used for both round and rectangular wire of the larger sizes. For smaller round wire there are some 300

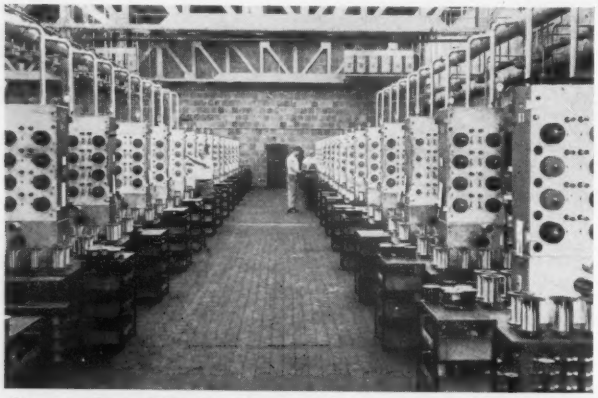

Figure 9—Part of the fine wire enameling machines. * * *

Figure 10—One of the packing lines in the shipping room. The powered lift platforms at each end adjust the pallet loads to the table height.

spindles of No. 1, No. 1½ and No. 2 vertical insulating machines. Bare wire for these is drawn in both of the first two drawing machine lines described previously, and is routed across to the bell annealer. Enameled wire, of course, is already annealed as it comes from the enameling room. All finished wire from this fabric covering section is trucked to and shipped from the same shipping center as is enameled wire.

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THE above description includes only the manufacturing processes of the plant but, in addition, there are several contributing services which are included within the plant and which are very necessary to its operation. The first of these is a die manufacturing and service room for the Carboloy wire drawing dies and for the small spring dies and the roller dies used in controlling the Formex enameling builds. The Carboloy dies are sized and polished from purchased, rough cored nibs. The spring dies, except for certain punch press operations, are made completed.

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A SECOND service section is that for spool inspection, cleaning and repair. Approximately 4,000 spools per day must pass through here on their return from customers. Some require almost no attention while others must be almost completely rebuilt or else scrapped. In order to minimize handling and to expedite the flow, conveyor lines are set up to carry the spools past cleaning, brushing, repairing and pressing equipment, and the corresponding operations are performed as needed.

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ANOTHER section of the floor is devoted to a chemical laboratory and to a development area with test ovens, etc., wherein is done much of the specific development and application work not handled by the company's more extensive general laboratories.

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STILL another section includes the various physical, electrical, and chemical test facilities required for the thorough quality inspection of wire samples. So far no mention has been made of inspection, and it may be well to say that the emphasis is largely on constant process inspection, feeling that it is the best assurance that quality exists throughout a spool and not just at the outside layer which is the only accessible portion. There are certain tests, however, which cannot readily be made in processing and which require sampling, and it is for these that the inspection facilities are made especially adequate.

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THIS, in a few words, is a description of the Fort Wayne Wire Plant of the General Electric Co. Laid out for straight line flow and easy material handling, and provided with the latest equipment in a modern building, it exemplifies the intention to make on a large scale the best possible wire.

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Figure 11—Looking past the bell annealing furnace into the fabric insulating section.

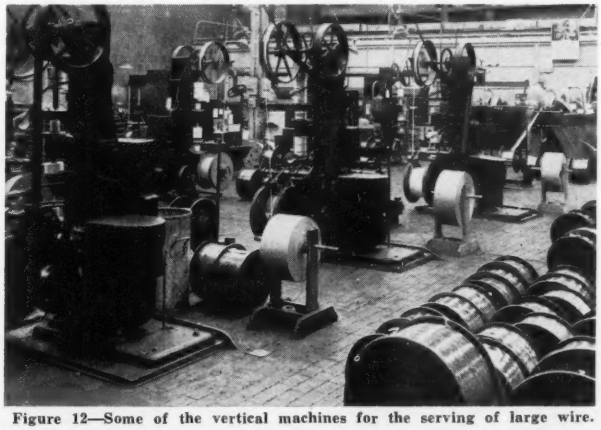

Figure 12—Some of the vertical machines for the serving of large wire.

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Processing of Stainless Steel Wire

By Stanley P. Watkins
Market Development Division
Armco Steel Corp., Baltimore, Md.

A description of some recent advances in the manufacturing techniques for stainless steel wire which have been developed as a result of customer demand.

THE production of stainless steel wire in this country has a short history in comparison with steel and non-ferrous metals, and although it was introduced commercially in this country in the early twenties, it was some years before stainless steel became of sufficient importance to get separate classification by the Iron and Steel Institute. The first figures on production were published in 1929, which indicated that 49,000 tons in all forms were produced that year. It was not until 1935 that figures on the production of stainless steel wire were available which listed production as 5,000 tons. Over the intervening years the production of stainless steel has grown steadily and last year the total production was reported to be 611,756 tons, of which 14,380 tons were in the form of wire.

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STAINLESS steel brought many new problems to the wire drawer, but over the years most of the basic problems have been solved and now the drawing of stainless is not a serious problem in most wire mills. However, as with most materials, as advancements are made in manufacturing techniques customers tend to tighten specifications to the point where it is a real problem to satisfy their requirements. A case in point is the development of electropolishing methods for imparting a bright finish to fabricated wire products. Prior to the introduction of this process, the only practical way to secure a bright finish on wire products was by mechanical means such as grinding and buffing. Light seams and pits on the surface of the wire can be generally removed by mechanical means but electropolishing accentuates such surface defects to a surprising degree. Since electropolishing is a cheap and convenient method for finishing fabricated wire products such as shelves and baskets, fabricators were no longer satisfied with wire having minor surface defects but demanded wire which after electropolishing was uniformly of high lustre and free of surface defects. This imposed severe problems in drawing and processing stainless steel wire which have not been entirely solved.

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THE quality of finished stainless steel wire depends to a great extent on the quality of the hot rolled rod. This is especially true in regard to surface finish. The carbon steel rod mills by the use of continuous mills with multiple stranding and high finishing speeds have increased tonnage rates, the stainless and alloy mills, with some exceptions, have continued to produce rods on hand type mills. This type mill has the basic disadvantage of low finishing speeds, long loops and little speed flexibility, with attendant low production rates. Since there are over 50 grades of stainless in regular commercial production, the rolling of stainless rods is a compromise, at best, as each grade has its hot working peculiarities which obvi-

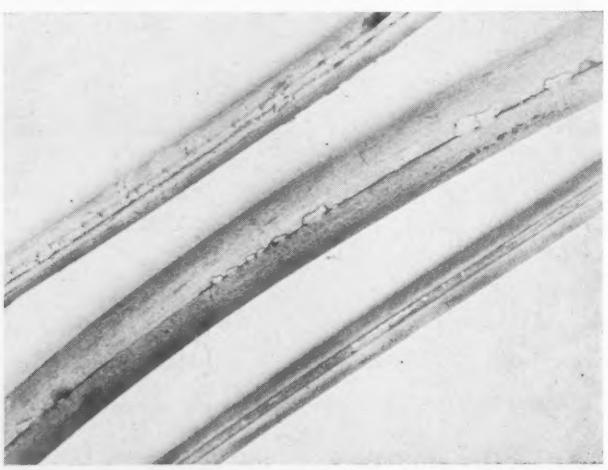

Fig. 1—Three types of defects, checks, seams and over-fills, which occur on the surface of hot rolled stainless rods.

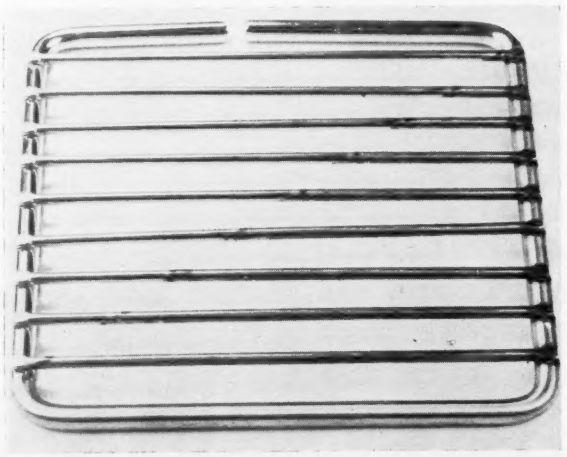

Fig. 1A—Electropolishing effects a high finish on products fabricated from stainless wire. As illustrated, it removes all scale and discoloration formed by resistance welding.

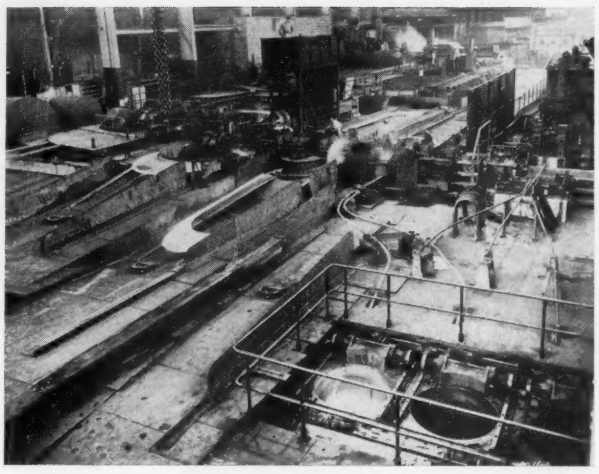

Fig. 2—View of modern rod mill designed especially for rolling stainless steel.

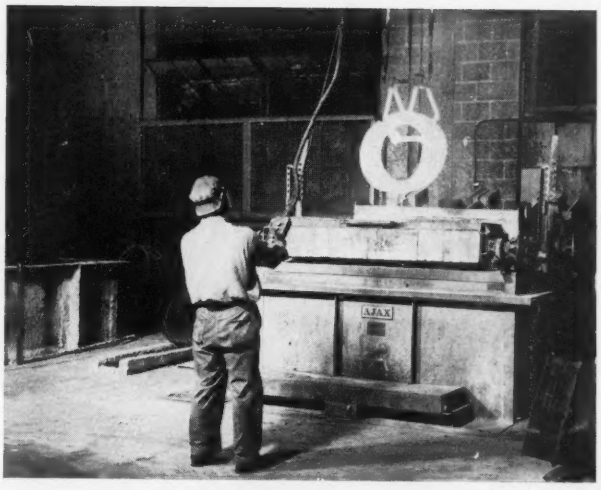

Fig. 3—Salt bath furnace for annealing stainless steel wire.

ously can't be accommodated by any one mill. All the stainless grades have in common the tendency to "pick-up" on roll guides and repeaters which results in scratched rods. In addition, they are not "free" scaling like carbon steel and careful heating of billets is necessary to prevent the formation of heavy scale which may be rolled into the surface and result in a rough and pitted surface.

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IN the last year a new rod mill went into operation in Baltimore which was designed to roll stainless steel rods exclusively. At present this mill is successfully rolling all the standard grades of stainless as well as many special grades into ⅝", ⅜", ¼" and #5 rods weighing from 375 to 250# at production rates of 8.5 to 6 tons per hour. The temperature drop from billet to finished rod is important with stainless as some grades require rolling in a rather narrow temperature range for best results. In this particular mill a 4" square billet weighing 250/265# is rolled to ¼" rd. in an average elapsed time of 2 minutes and 18 seconds. Such a billet of 18-8 stainless taken from the heating furnace at 2150/2200° F. will finish into ¼" rd. at approximately 1725°F. Related to drop in temperature of the entire rod, is the problem of variation of temperature from end to end of each coil which influences uniformity of gauge and physical properties.

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ALTHOUGH this mill is highly mechanized, rods produced are singularly free from guide and repeater scratches, and tolerances are regularly held to a variation of .004" in gauge from end to end of coil.

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AS mentioned above, there are over 50 grades of stainless in regular production, but the bulk of stainless steel wire is produced in only 7 grades: chromium-nickel Types 302, 304, 308 and 316, chromium Types 410, 430 and 420. Each of these grades has its peculiar and individual properties which must be taken into consideration in processing rods into finished wire.

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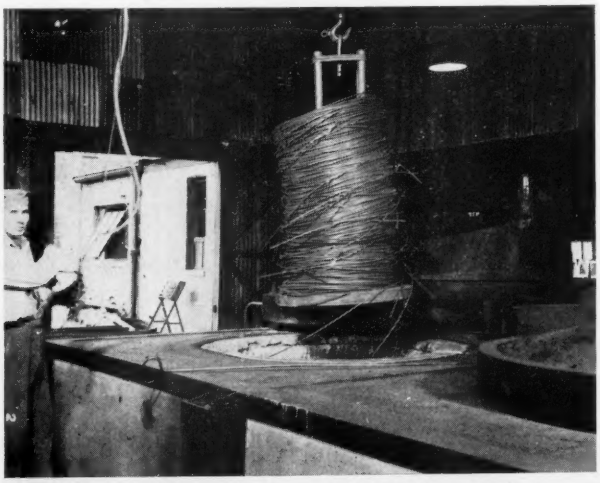

Fig. 4—Pit annealing of stainless steel wire.

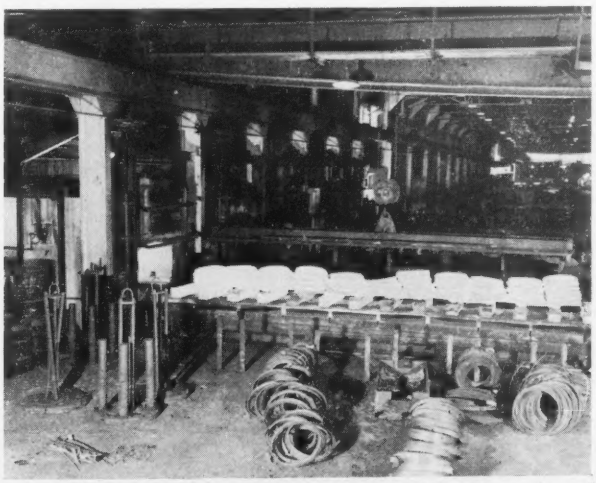

Fig. 5—Car type furnace for annealing stainless steel coils.

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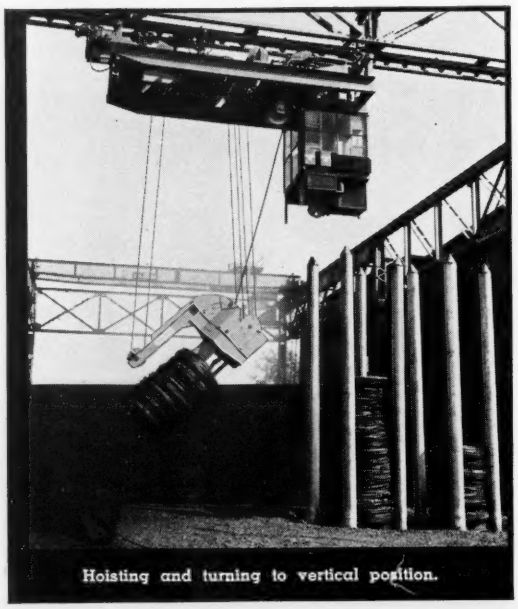
Threading hook into rod in horizontal position.



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The grab mechanism is actuated by a built-in hydraulic pump which causes a spreader plate to expand or retract. In the expanded position, sufficient pressure is exerted against the inside diameter of the coils to hold them firmly during handling.

The first installation of the equipment has just been completed. It is in a building with a truss height of 40 feet. Rod will be stored to a height of 22 feet.

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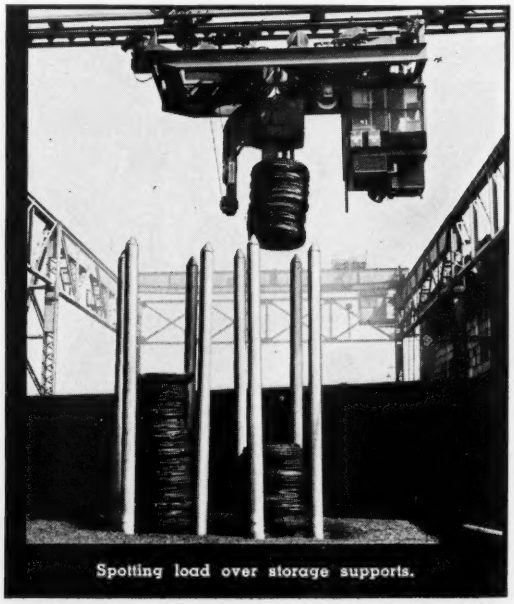
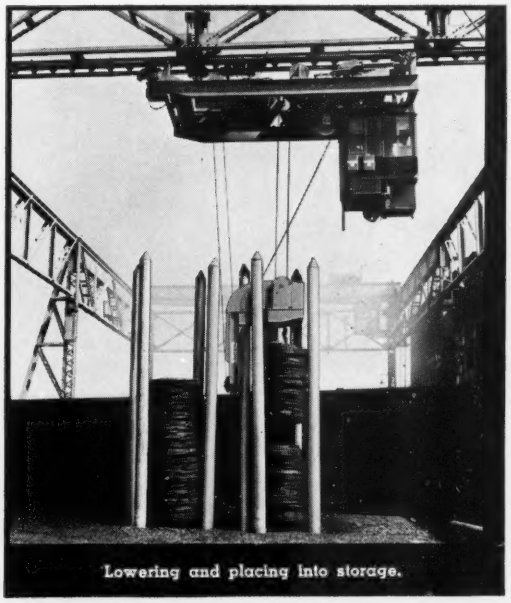


Spotting load over storage supports.



Lowering and placing into storage.

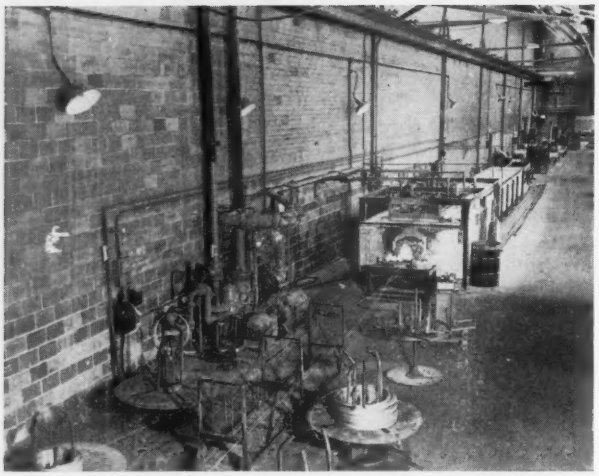


Fig. 6—Bright annealing furnace of strand annealing stainless steel wire.

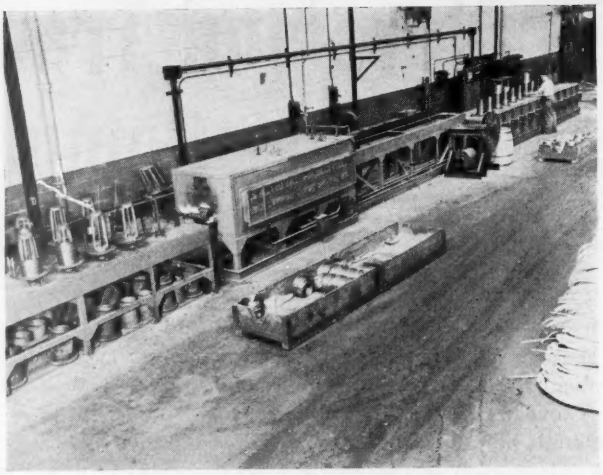


Fig. 7—Bright annealing furnace for small diameter wire. * *

IN rolling the chromium-nickel types from billets to rods, a generally higher temperature is employed (2200° F.) than is used with chromium types which are heated no higher than 2050° F. The chromium grades are susceptible to grain growth at elevated temperatures as well as scaling heavily so it is desirable to roll these grades at as low a temperature as feasible.

★ ★ ★

THE chromium-nickel types and chromium Types 410 and 430 rods can be air cooled from the hot mill, but Type 420 and similar high hardenability grades should be slow cooled from the mill to prevent thermal cracking. With such grades the best practice is transfer immediately after rolling to a furnace held at 1525/1550° F. and soak for 2 to 3 hours, and slow cool to under 300° F. After rolling, rods are annealed, pickled, and inspected before further processing.

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ANNEALING of the chromium-nickel grades is generally carried out in car or rotary type furnaces so constructed that the car hearth can be readily removed and the load quickly quenched in water. Rapid cooling is necessary in order to obtain maximum ductility and retain carbon in solution. The heating cycle naturally varies with the load and type of furnace. A temperature of 1850/1900° F. for ½ hr. soak is generally used for annealing the chromium-nickel types. The average hardness of annealed rods is Rockwell B-78/83, which is adequate for cold drawing. Salt bath furnaces can be used for annealing 18-8 stainless, and in this type furnace the annealing cycle is short in comparison with the car or rotary furnaces. Salt bath furnaces do not appreciably scale the surface, but must be carefully controlled and rectified in order to prevent pitting. Experience has shown that maintenance of a slightly oxidizing atmosphere (5 to 10% excess air) is more desirable than a reducing atmosphere. It seems desirable in annealing stainless to slightly oxidize the surface as quickly as possible as such a film tends to protect the surface from pitting, a condition sometimes encountered when annealing is carried out under reducing conditions. Also, the scale

Fig. 8—Modern pickling room for descaling stainless steel coils. *

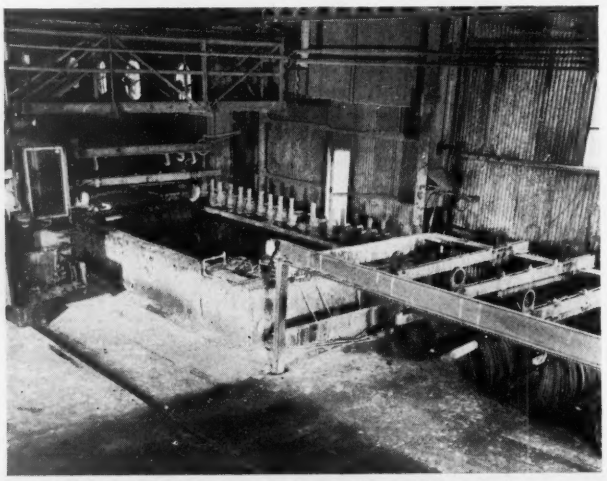
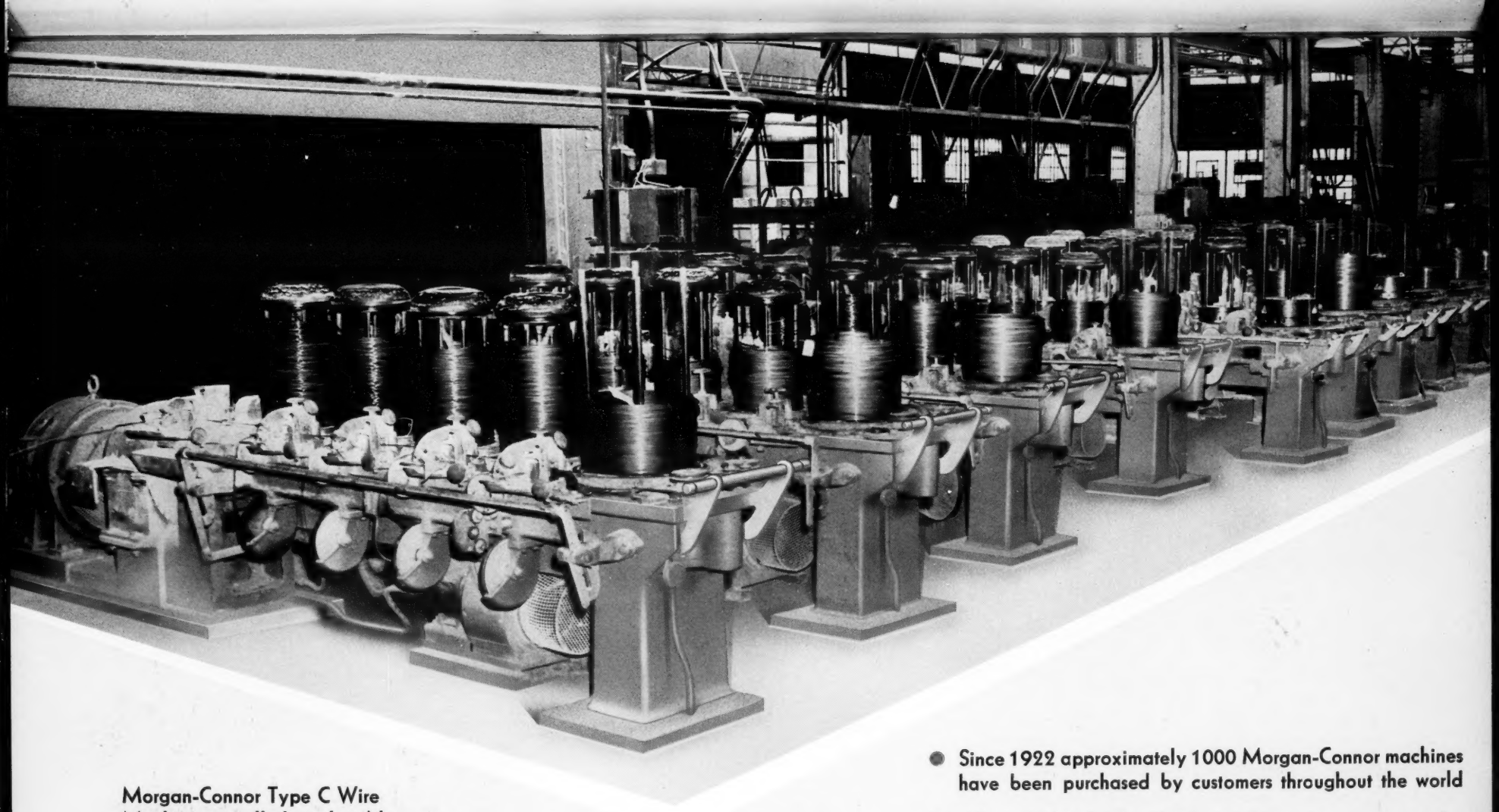


Fig. 9—Sodium hydride bath used for descaling stainless steel wire. *



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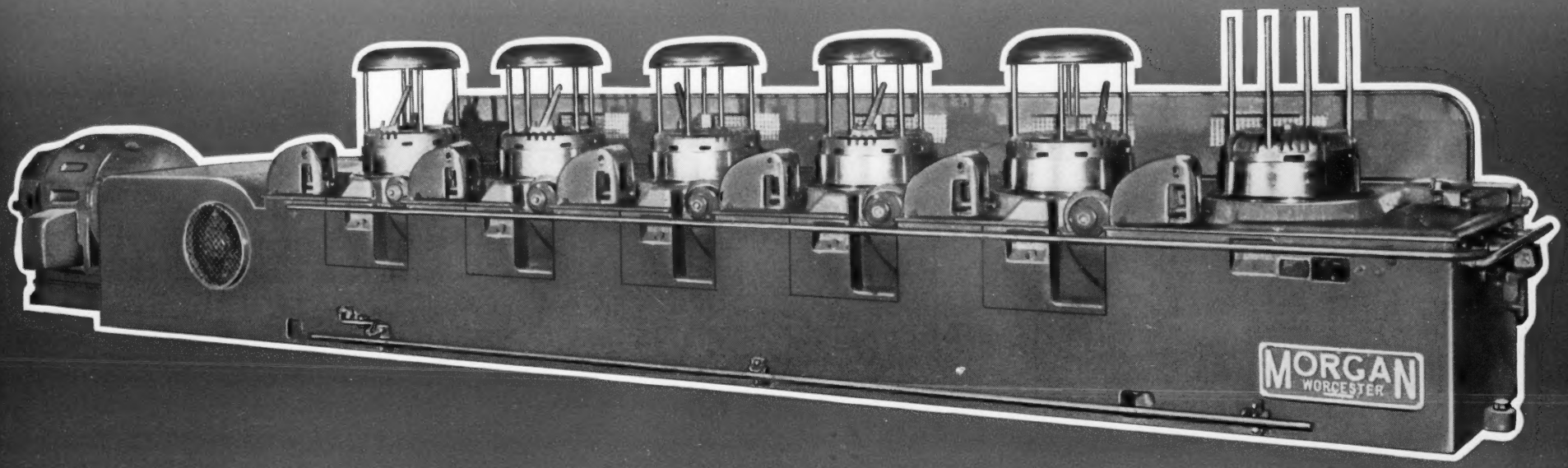

MORGAN CONSTRUCTION COMPANY, Worcester, Massachusetts

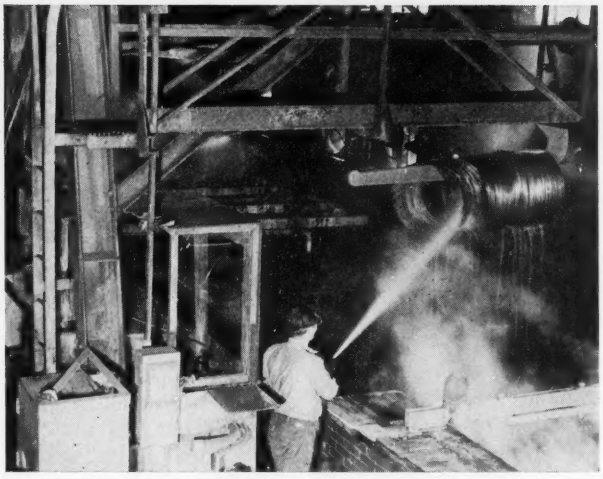

Fig. 10—Washing descaled coils with high pressure water hose.

formed under oxidizing conditions is easier to remove by pickling.

★ ★ ★

THE chromium grades are annealed at 1500/1525° F. which is somewhat lower than used for the chromium-nickel types. Most any type of furnace can be used, and in practice car type, pit type and salt bath are generally used. Air cooling from the annealing heat is general practice, although water quenching is permissible with types 410 and 430. The annealed hardness depends on the grade, ranging from Rockwell 77/83 in the case of Type 430 to B-90 for Type 420.

★ ★ ★

AFTER annealing it is necessary to remove heat treating scale from the rods by pickling and prepare the surface for cold drawing if they are to be processed to a smaller size.

★ ★ ★

THE pickling of stainless is difficult in comparison with carbon steel, as the scale is tightly adherent and the base metal is inherently resistant to acid attack. These conditions are not conducive to easy or rapid pickling. Also, some grades are more readily attacked by acid pickling solution so that it is a difficult job to maintain a solution which will do an acceptable job on all grades of stainless. Many solutions have been proposed and used for pickling stainless, but at present most producers are using a basic acid method consisting of a sulphuric acid bath (5-10%) plus an inhibitor (1-2%) at a temperature of 140° F. and a nitric acid (3-5%)-hydrofluoric acid (½-1%) at room temperature. In practice, coils are immersed in the sulphuric acid bath for 15-30 minutes, depending on the grade, and then washed with pressure hose, then immersed in nitric-hydrofluoric acid bath for 5-20 minutes, followed by thorough washing. Careful supervision and maintenance of baths are necessary to prevent "pickle burning" or pitting, especially of the chromium grades, which are more susceptible than the chromium-nickel types.

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IN recent years several new methods for pickling the stainless steels have been introduced, which employ molten salt baths (700/900° F.) supplemented by short acid dips. Two such methods

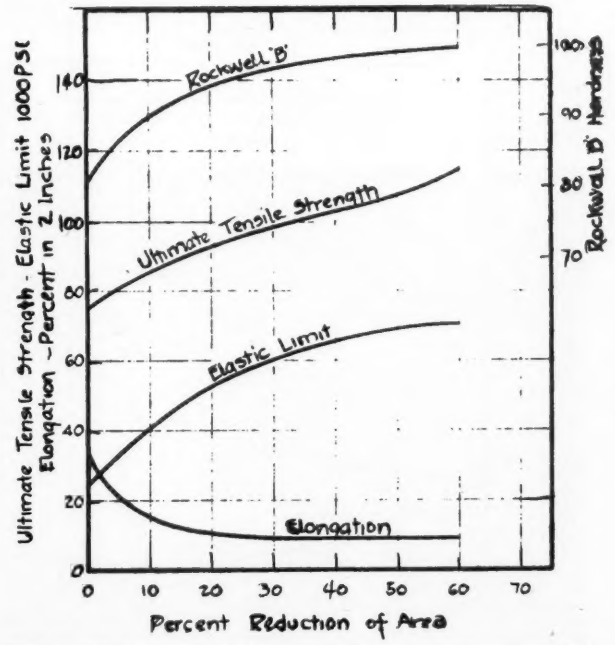

Chart A—Effect of cold drawing on tensile properties of annealed 12% chromium stainless steel.

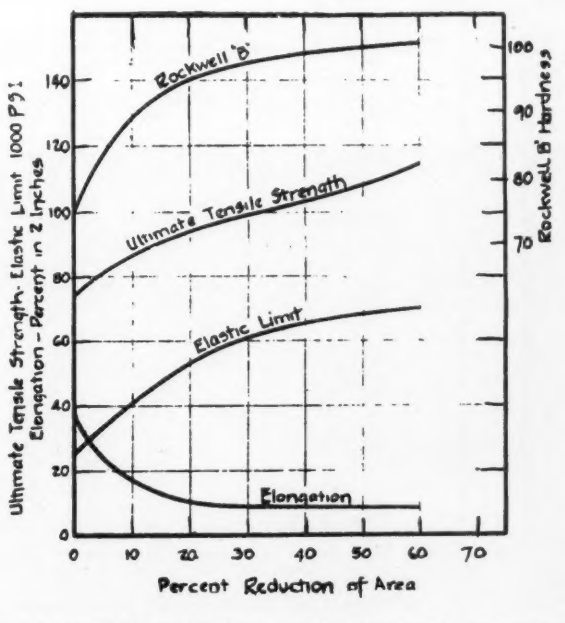

Chart B—Effect of cold drawing on tensile properties of annealed 17% chromium stainless steel.

are the duPont Sodium Hydride bath and the Hooker salt bath. Both methods have been in use for some years and have proven most satisfactory for de-scaling all stainless grades. They are characterized by ability to remove scale with practically no metal loss and no danger of pitting, plus a short pickling cycle. A typical cycle for pickling 18-8 stainless coils is as follows:

1) 15 min. in salt bath
2) Water quench
3) Pressure wash
4) 10 min. in 10% sulphuric acid bath at 140°F
5) Pressure wash
6) 15 min. in nitric (5%) -hydrofluoric (1%) acid bath at room temperature
7) Pressure wash

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THE same practice is followed in de-scaling the chromium grades except that the time in acid baths is generally halved.

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AFTER annealing and pickling coils are carefully inspected for defects such as seams, checks, laps and over-fills. When possible such defects are removed by grinding. After inspection satisfactory coils are released for further processing.

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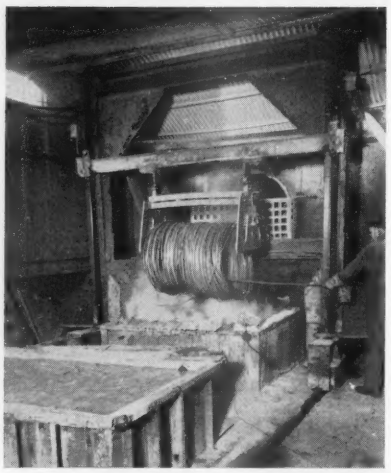

Fig. 11—Leading of stainless steel coils. * *

IN order to take heavy drafts on stainless, it is necessary that the surface be coated with a metallic or other material having low antifriction and galling properties. Up to the present time lead has been the most satisfactory coating for the roughing drafts, although other materials have been used with success. The first drafts are usually quite heavy, and the per cent reduction depends on the grade being drawn. For example, it is general practice to reduce ¼" diameter, Type 430 (17% Chrome) and Type 302 (18-8) to .110" diameter in 6 drafts, a total of 80.5% reduction. It is not possible to take such heavy drafts between process anneals with the higher carbon chromium grades, such as Type 420. It is universal practice to use carbide dies for drawing stainless wire, especially in sizes above about .030", and a die room suitably equipped for dressing and polishing dies is an essential part of a wire mill. The design of dies for drawing stainless is quite important, and the general practice is to keep the bearing as short as possible and the approach angle from 12° to 16°, depending on die size, and back relief 30°. Dies must be highly polished and free of imperfections, as stainless is easily scratched and "picks-up" on dies readily. The speed of drawing varies with the draft and also the grade, but roughing drafts on Types 430 and 302 can be as high as 300 feet per minute. In the intermediate and smaller sizes where the drafts are lighter speeds as high as 550 feet per minute are possible and feasible. Much higher speeds are possible in drawing fine wire with diamond dies. To reduce handling and drawing costs, it is customary practice to weld small coils together by the electric resistance method. This should be done in the annealed rods, as many users object to welds when made in the near finished or finished size. The chromium-nickel grades resistance weld without difficulty, but the welding of the chromium grades

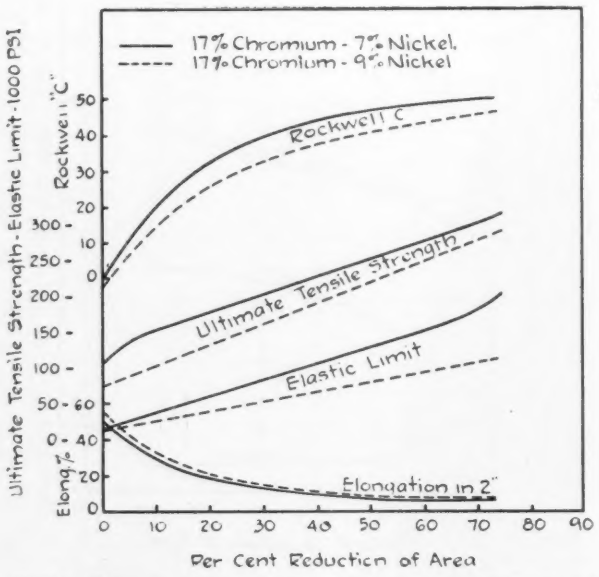
17% Chromium - 7% Nickel
17% Chromium - 9% Nickel
Rockwell "C"
Ultimate Tensile Strength
Elastic Limit
Elongation in 2"
Ultimate Tensile Strength - Elastic Limit - 1000 PSI
Elong. %
Per Cent Reduction of Area

Chart C—Effect of nickel content on the work hardening rate and tensile properties of cold drawn 17-7 stainless steel * * *

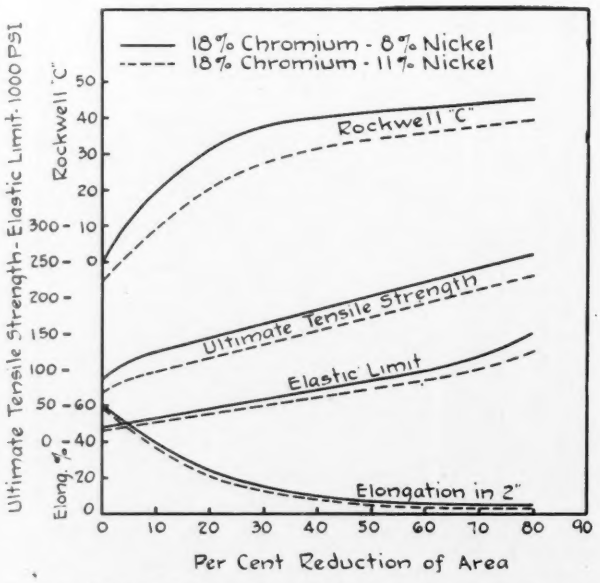
18% Chromium - 8% Nickel
18% Chromium - 11% Nickel
Rockwell "C"
Ultimate Tensile Strength
Elastic Limit
Elongation in 2"
Ultimate Tensile Strength - Elastic Limit - 1000 PSI
Elong. %
Per Cent Reduction of Area

Chart D—Effect of nickel on the work hardening rate and tensile properties of cold drawn 18-8 stainless steel. * * * * *

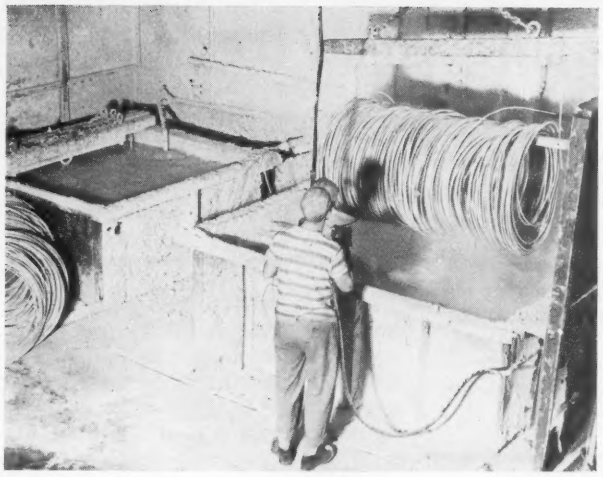

Fig. 12—Liming stainless steel coils prior to cold drawing.

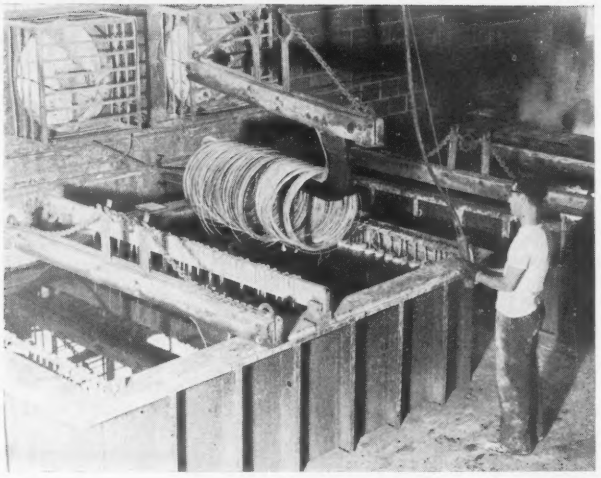

Fig. 13—Electroplating copper on stainless steel wire.

presents more of a problem. The non-hardenable chromium grades such as Type 430 weld easily enough but the welds are apt to be brittle and tend to break when passing through the die. Owing to the air hardening characteristics of hardenable chromium grades, they are not generally resistance welded to increase coil weights.

★ ★ ★

A TYPICAL processing set-up for .045″ diameter annealed Type 430 wire, starting with ¼″ hot rolled rods, is outlined below:

¼″ hot rolled rod
Anneal, pickle, coat
Rough to .115″ diameter in 6 passes (79% reduction)
Strip (if lead coated), process anneal (1400/1425° F 2 hrs.), pickle, coat
Rough to .045″ diameter in 7 passes (84.5% reduction)
Strip
Bright anneal (1450°F—50 ft. per min.)

★ ★ ★

THE practice for Type 302 in the same size is quite similar, except that the process anneal is carried out at 1900°F. if done in other than bright annealing furnace, and in this furnace at 2000° F. at speed of about 40 ft. per min. and rapidly cooled. The hardenable chromium grades require a longer heating cycle than the other stainless grades and slow cooling is necessary to secure best ductility.

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IF lead is used for drawing lubricant, it is extremely important that it be removed entirely before wire is process annealed. If lead is not completely removed, it will often cause pitting of the surface during annealing. Stripping is accomplished by treating in a 5-10% bath of nitric acid at 140/150° F. for about 15 minutes. To test for completeness of lead removal, a dilute solution of sodium dichromate is sprayed on coils and if lead is present on the surface a yellow precipitate will form which indicates incomplete removal of lead.

★ ★ ★

OWING to the tendency for stainless to "pick-up" on dies, it is necessary to coat the surface with a lubricant which has good covering power and will not break down under heat and compression when passing through the drawing

(*Please turn to page* 968)

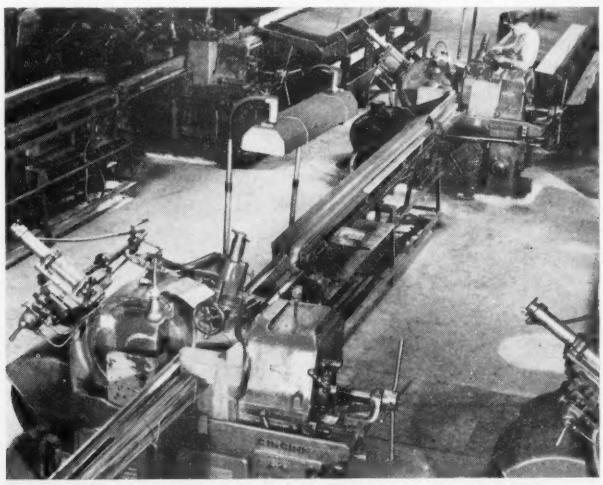

Fig. 14—Centerless grinding of rods straightened from coils.

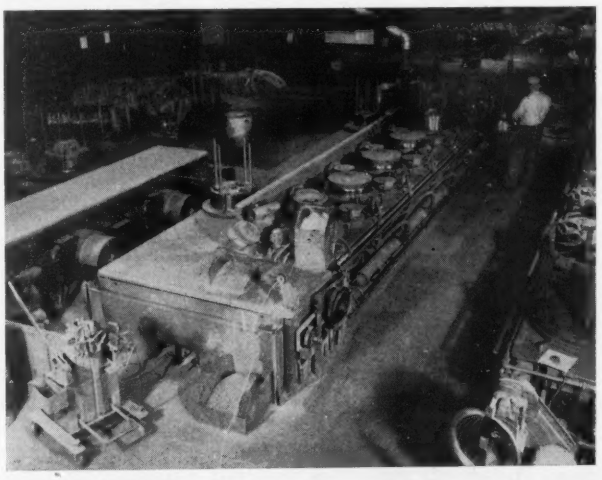

Fig. 15—Modern high speed tandem draw bench for cold drawing stainless steel wire.

The Nylon Coating of Wire

By C. A. Litzler, Chief Engineer

Industrial Ovens, Inc.

Cleveland, Ohio

A discussion of the methods and equipment required in the application of nylon dielectric coatings in the manufacture of electric conductors, prepared for presentation at the Wire Association Convention October, 1949.

BECAUSE of the many desirable electrical and physical properties nylon possesses, this material, in the past several years, has come to play an important role in the electrical insulated wire industry. It has, in many instances, replaced other types of jacketing materials for the heavier cables and, on the smaller cables, has made heavy inroads on the synthetic and orthodox type of wire enamels.

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THE increased use of this material is most important in the general fields of fine magnet wires for radio and television, for stator winding of fractional horsepower motors and as an abrasion resistant casing which is applied to polyethylene or polyvinyl chloride jacketed conductors.

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BECAUSE of its wide acceptance by the wire industry, due to such flexibility, it might be important to define the term **"nylon."**

★ ★ ★

BASICALLY, the term **"nylon"** is a generic term for any long chain polymeric amide which has recurring amide groups as an integral part of the main polymeric chain. These molecular groups are capable of being formed into a filament in which the structural molecular elements are oriented in the direction of the axis of the drawn or the extruded material.

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ACTUALLY, this definition, in its strictest sense, covers only those phases of the material which are of interest to a chemical engineer. The simple definition does not cover the versatility of this material as an insulator and, naturally, this fact is of direct interest to the cable engineer or the wire mill executive.

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HOWEVER, the cable engineer is very much interested in the physical properties of nylon. Its principal physical property is its abrasion resisting capacity. As such, it is superior to polyethylene and polyvinyl chloride and, because of that fact, nylon is often used as a sheathing material on previously jacketed polyethylene or polyvinyl chloride cables or wires. It has excellent resistance to abrasion in any single direction and in this resistance, it is more suitable, in many instances, than neoprene, rubber or the more simple cotton or fibrous braid with lacquer coating.

★ ★ ★

ELECTRICALLY, it has a dielectric strength of 1500 volts per mil of thickness, which compares to PVC dielectric constant of 375 volts per mil and polyethylene dielectric constant of 420 volts per mil. Thus, we can see that nylon is 4 times superior to PVC and 3.6 times superior to polyethylene. These two latter being the more common thermoplastic jacketing materials.

★ ★ ★

IN radio and television hookup wire, its principal benefit is the ease of soldering lugs and connections to the ends of these wires without mechanical stripping. In similar instances, polyvinyl chloride or polyethylene break down thermally, due to the heat of the soldering iron, and, therefore, they require mechanical stripping plus extreme care in the soldering of connections.

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AFTER the polymerization of the nylon molecule has occurred, nylon is resistive to most commercial chemical solvents. There are some exceptions to this particular quality, the most noticeable ones being the Phenol group, Crysylic Acids and Formic Acids and some mineral acids; the principal one being Sulphuric Acid.

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BESIDES presenting other advantageous physical characteristics, nylon has the added benefit of simple applications to wire or cable. The two most common methods of application are the solution method and the hot melt or extrusion method.

★ ★ ★

The Solution Method of Nylon Application

THE solution method, as its name implies, is one in which the nylon is dispersed in a liquid solvent, principally Crysylic Acid, and in the liquid state, it is applied to bare wire. This particular operation is, however, confined to the relatively small diameter wires extending from the neighborhood of 12 gauge on up to as fine as 40 gauge.

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NATURALLY, the equipment essentially consists of the wire handling equipment, the dipping equipment and the solvent evaporating and nylon polymerizing equipment. In this type of applica-

tion, the solvent is used only as the vehicle of the material and, as such, must be evaporated before or simultaneously with the polymerizing operation. Actually, the use of these relatively expensive solvents contributes to the overall cost of nylon coating but the solution method presents other offsetting factors when considered as a method of application in direct comparison to the hot melt method.

★ ★ ★

IN the solution method, equipment that is somewhat similar to conventional enameling equipment is used. As such, relatively large numbers of ends of wires are handled in the system at a processing speed appreciably less than that of the same wire sizes when the nylon is applied by the extrusion method.

★ ★ ★

HOWEVER, there are distinct advantages to both systems and the principal advantage of the solution method is the control of solids and thinness of coat which can be applied. Usually, in nylon coating of, let us say, .002″ to .004″ in total thickness, it is possible to apply individual coats at the approximate thickness of ½ mil per coat. Thus, on a six coat application, approximately .003″ of nylon is deposited on the wire. The principal reason for using the solution method is to obtain thinner coats on finer wires than it would be practical to apply by an extrusion method.

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BECAUSE the speeds are approximately one twentieth of the speeds of extrusion method, it is possible to handle wires of very fine gauge without danger of breakage and without the loss of footage due to frequent wire rethreading.

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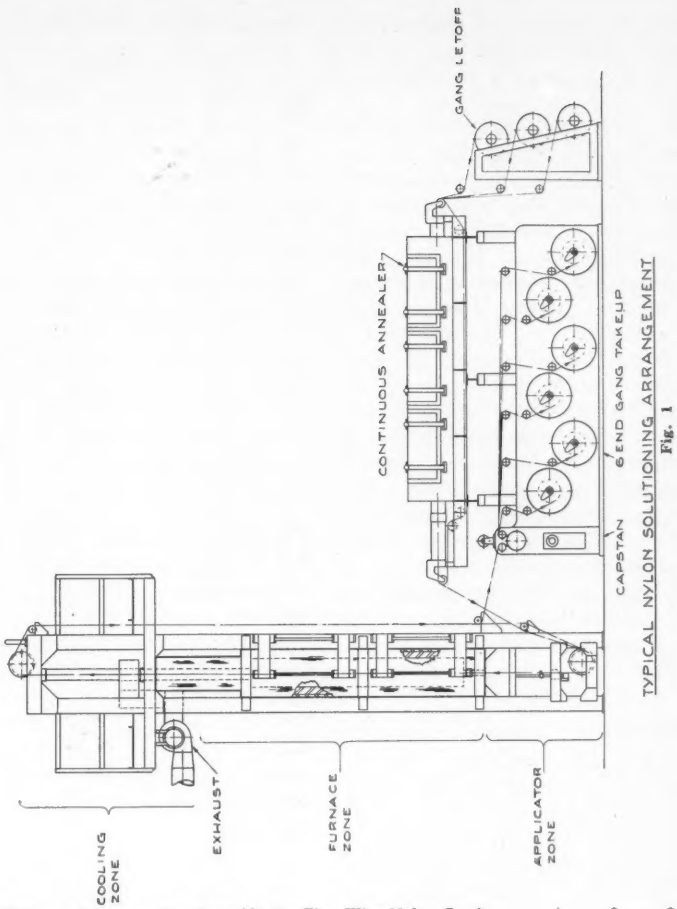
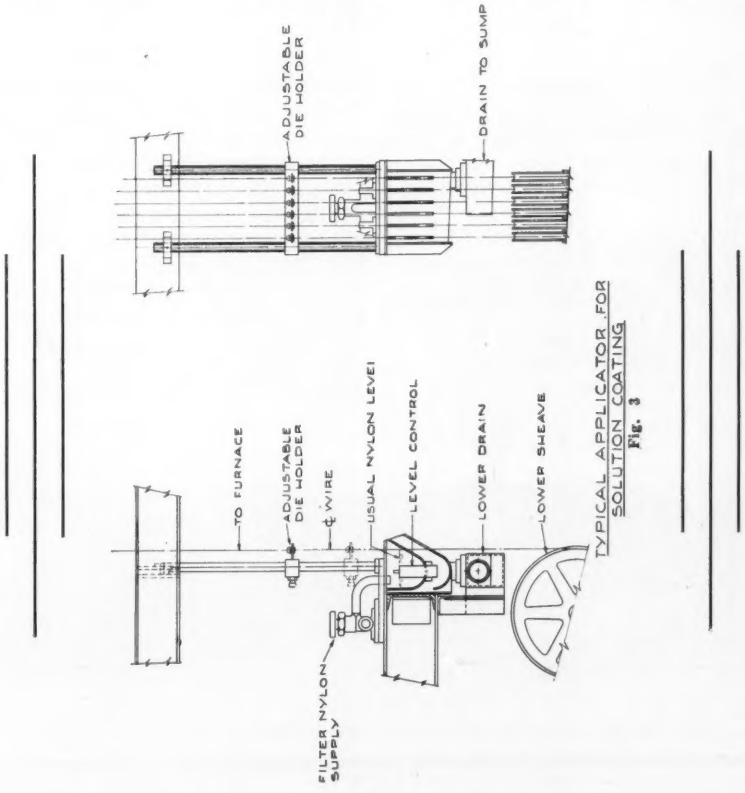
ESSENTIALLY, the solutioning method consists of the same general type of equipment that is used for the application of conventional and synthetic enamels. There are a certain few modifications as to temperature and the basic application method as compared to the conventional enamel



TYPICAL NYLON SOLUTIONING ARRANGEMENT
Fig. 1

Complete Tower and Preannealer Assembly for Fine Wire Nylon Coating.



TYPICAL APPLICATOR FOR SOLUTION COATING
Fig. 3

and these particular differences will be mentioned later.

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THE greatest difference is in the application system. In the application system, in conventional enamel, the dip and flow method is satisfactory. However, in the nylon method, due to the viscosity of the nylon as applied in the solution method, sizing dies are not only advantageous but also desirable from the standpoint of coating control buildup. By the actual careful drilling of the die orifice in relation to the wire diameter, it is possible to very accurately control the buildup per pass. The solutioning methods, apply either four, six or eight total coats on the wire. By variation in the numbers of coats and on the thickness per coat, accurate size control of the total diameter buildup can be established.

★ ★ ★

WIRES that are quite suitable for the solution coating would be wires extending from, let us say, 18 gauge AWG to 44 gauge AWG. Anyone of these particular wires coated with the usual thin amount of nylon coating are efficiently handled by the solution equipment.

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A TYPICAL example of a nylon solution wire coating system is shown in Figure 1. You will notice that the following equipment is shown in this arrangement:

1) **Letoff Stands.**
2) **Continuous Wire Preannealers.**
3) **The Application System.**
4) **The Evaporating and Polymerizing Furnace.**
5) **The Cooling Zone.**
6) **The Gang Takeup.**

★ ★ ★

The Letoff Stands or Supply Reel Stands

BY the solution method, maximum economy is gained by the use of a relatively large number of ends of wire. Some installations extend from six through twelve to even twenty-four ends, depending upon the size of the wire involved and the number of coats. Because of the wide numbers of ends that are normally employed in this system and because of the relatively small size of fine wire spools, a conventional enameling type of supply spool stand is usually used.

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ON the fine spool sizes, very accurate tension controls must be provided in order to prevent possible snarling of the wire or breaking of the wire in the case of wire kinks or entanglements. The stand shown in the illustration is a typical twelve spool letoff stand. A good gang type letoff stand, suitable for conventional enameling, is suitable for nylon coating.

★ ★ ★

In-Process Preannealers

BECAUSE some wire mills are not equipped with furnace type annealers, or because of the impossibility of purchasing satisfactory annealed soft copper wire, it is advisable that a continuous wire preannealer be installed in the system prior to nylon coating. The particular preannealer shown in Figure 2 is specifically designed for handling twelve ends of number 20 gauge wire continuously. In its operation, it operates within the temperature range of 1200 to 1300 degrees fahrenheit and provides a non-oxidizing atmosphere. Superheated steam or a regular non-oxidizing atmosphere gas is used.

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THE principal purpose of showing this preannealer is to explain its relative position in the process. Depending on the process wire speed, the annealer will be of varying lengths. The primary consideration in the selection of a preannealer is that it has an adequate capacity to bring the wire past the critical annealing temperature within the time that the wire is in the high-temperature zone. The annealer can be positioned in various manners, the one shown being suitable for most situations.

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Applicator System

THERE are several different methods of the application of liquid nylon to the wire itself but, after due deliberation, this particular one was selected.

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FIGURE 3 shows a cross-section view of an efficient system for the metered application of the liquid nylon on the wire. It consists, essentially, of the necessary filtering viscosity control and pumping system (not shown) which delivers the prepared nylon solution through the metering valve and into the top applicator tank. This applicator tank is provided with adjustable level control and the necessary clearance slots for the wire to pass through. In operation, the level control is positioned slightly above the bottom of the slot so that there is a bank of liquid nylon always available for contacting the wire which passes through the slots and the nylon bank, as indicated. The velocity of the wire and the viscosity of the wire usually prevent the flow of nylon through the work slots. The amount of nylon pumped into this upper trough is metered by the needle valve in the pressure line. Excess solution pours either through this slot or through the overflow into the collector pan beneath.

★ ★ ★

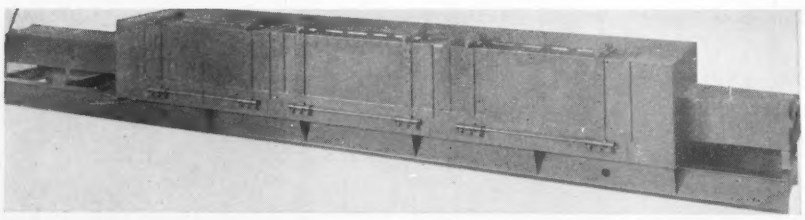

Fig. 2
Twelve End Continuous Preannealer for Solution Coating.

THE collector pan is connected to the nylon reservoir filtering and pumping system. After it applies itself to the wire, the nylon is carried vertically upward by the velocity of the wire, then through the floating sizing dies, quite similar to the cable lacquering dies. These dies are mounted on die plate holders which are so constructed that the die is free to float about the centerline of the wire.

★ ★ ★

ADJUSTMENT, to compensate for viscosity of nylons, is allowed by adjusting the die and the die holders on adjustably raisable and lowerable mountings. The heavier the nylon solution, the higher the die is mounted away from the application tank. With this adjustable feature, the same basic system of applications can be used with various solvent and nylon solutions as well as various other types of conventional or synthetic enamels. By the simple expediency of die positioning, and several other adjustments, a very flexible combination system of solution coating for nylon or enamels is possible.

★ ★ ★

The Polymerizing Furnace

IN conventional enameling, as well as nylon coating, high temperature evaporating and polymerizing furnaces are used. In the normal operating temperature range, they run in the neighborhood of 600° to 700° F. for nylon.

★ ★ ★

THESE furnaces generally are of the vertical type, completely insulated with refractory brick backed up by a suitable insulating material. This entire structure is contained in a structural framework which is rigid enough to prevent extraneous vibrations from reaching the system and thereby throwing minute vibrations into the wire traveling through the system.

★ ★ ★

THE unit shown in Figure 1 is electrically heated. The heat energy is applied directly by a combination of radiant and convection heating methods. The radiant heating is brought about by the direct radiation from the electrical elements to which the wire is exposed. As these elements operate at face temperatures of approximately 900° to 1200° F., most of the heating of the wire is by direct radiation. As in the case of any tower, furnace or oven installation, the convection chimney affect is partly responsible for the transfer of heat to the wire.

★ ★ ★

IN a system of this type, especially those handling fine wire, the convection currents should be held to a reasonable minimum because of the movement and vibrations that would be produced in the wire by these convection currents. These vibrations in the wire result in ridges in the coating and should be prevented if at all possible.

★ ★ ★

IN discussing the furnace design and construction, it is necessary that care be taken to prevent the application of too much heat to the wire at the entry end of the furnace. If heat is applied at too great a rate to the wire, the entrapped solvents are liberated from the solution too quickly. This produces pitted wire or complete breaks in the coating itself. In normal operation, there is a gradual rise in the wire temperature from the entering slot in the bottom of the furnace to a point approximately one-third of the entire height of the tower. It has been found, from experience, that if this temperature gradation is correct pitting of the nylon surfaces never occurs.

★ ★ ★

The Cooling Zone

BECAUSE the material is thermo-setting, it is important that as much of the residual heat be removed from the nylon and the copper conductor before it is passed over any sheaves. If the wire is not sufficiently cooled, the nylon coating picks off onto the sheaves, resulting, of course, in imperfect coating of the wire. In order to prevent the occurrence of such conditions, convection cooling systems are used. They consist essentially of a high velocity jet system employing the convection cooling air passing in a counterflow direction to the passage of the wire. Also, it is important to reduce the temperature of the wire before the application of the next coat to prevent preliminary thickening of the nylon before the wire and the excess solution passes into the die.

★ ★ ★

Gang Takeup

BECAUSE the problem here, at this point, is again similar to the conventional enameling problem, a gang takeup of sufficient number of ends is usually sufficient. Like any other wire coating process, it is indeed important that the capstan propelling the wire be absolutely smooth in its propulsion. Usually in this solution method, because of the extreme thinness of coat, pulsations developed by a jerkily operated capstan can react on the wire and set up a harmonic on the wire in the system and develop a series of concentric rings in the coating. Inasmuch as this gang takeup is a conventional operation, there is nothing further that needs to be said about it here.

★ ★ ★

General

IN the overall consideration of the solution method, its principal advantages can be stated as follows:

1) **It can be used to apply relatively thin coats of nylon to the wire.**
2) **Nylon applied by the solution method adheres more tenaciously to the copper conductor.**
3) **Dip and flow can be used on very fine wire sizes without excessive production or scrap loss.**
4) **Relatively smaller amounts of floor space are required for this method as compared to the extrusion method.**

★ ★ ★

THESE principal advantages are especially important if the producer of nylon wire is particularly interested in small wire gauges. It could almost be said that this type of application has its most advantageous operations in wire sizes over 18 gauge.

★ ★ ★

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THE Aetna-Standard WIRE DRAWING Unit

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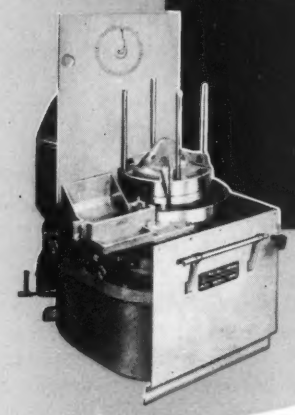

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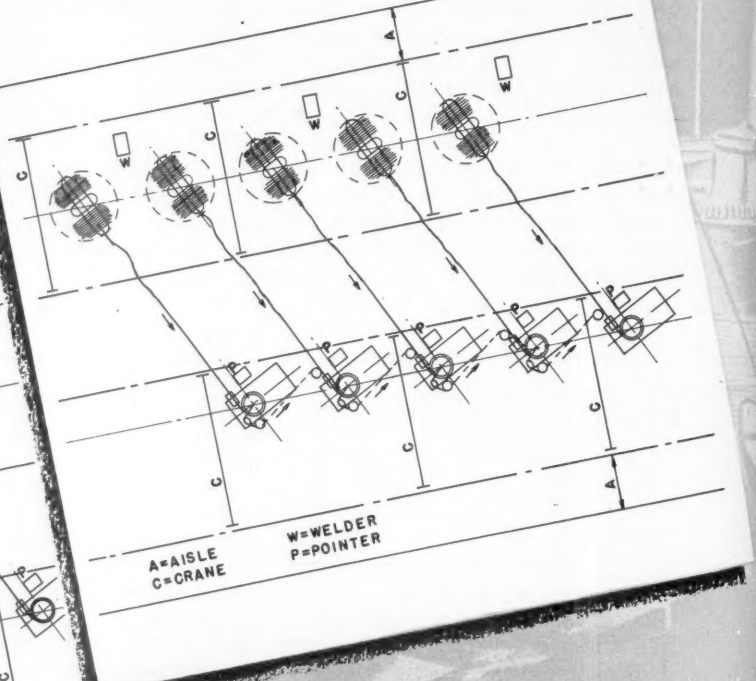
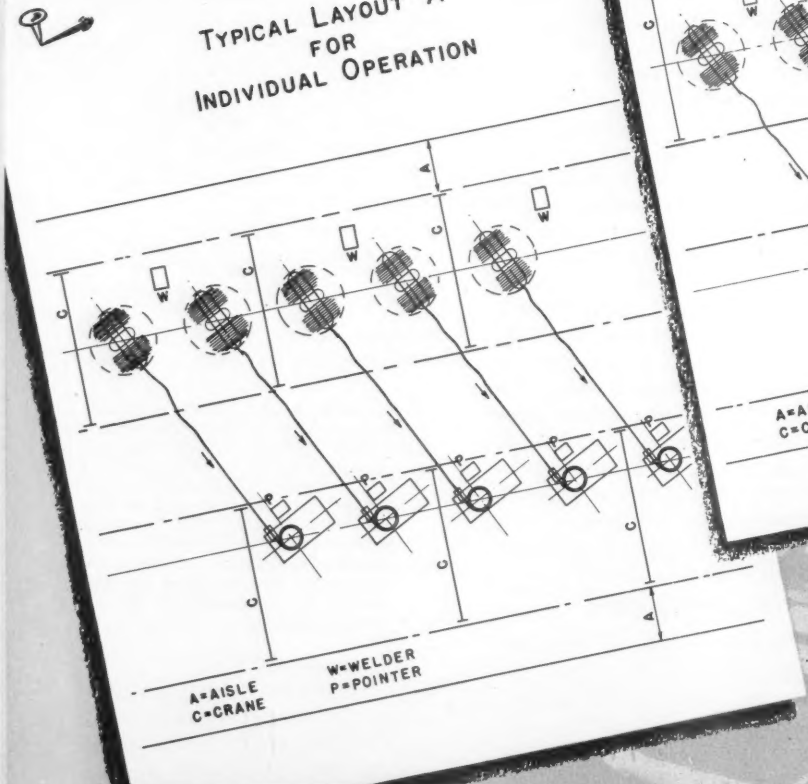
TYPICAL LAYOUT "B" FOR INDIVIDUAL AND TANDEM OPERATION



TYPICAL LAYOUT "A" FOR INDIVIDUAL OPERATION



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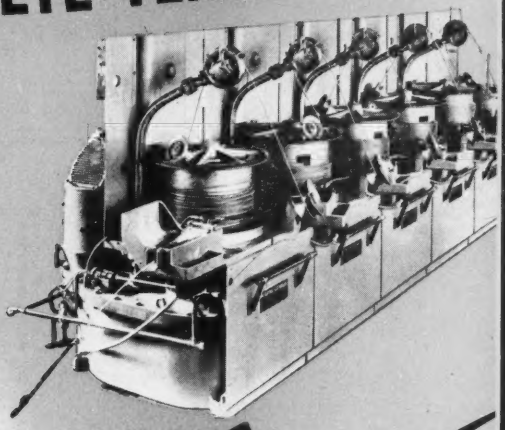

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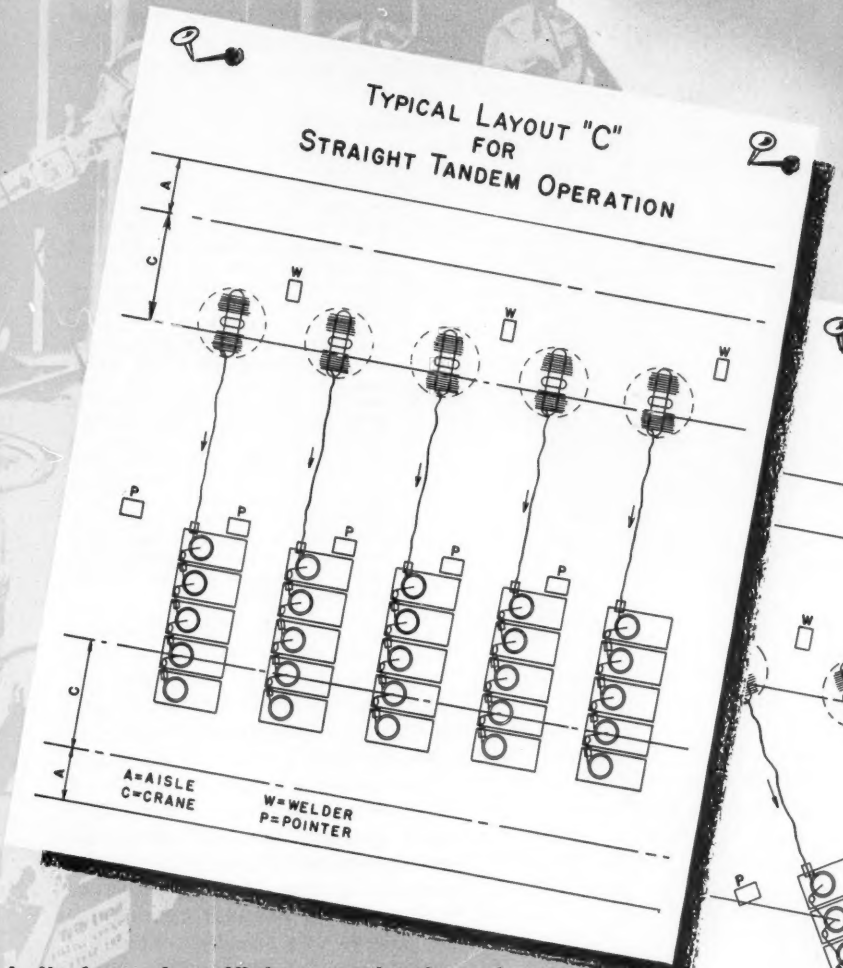

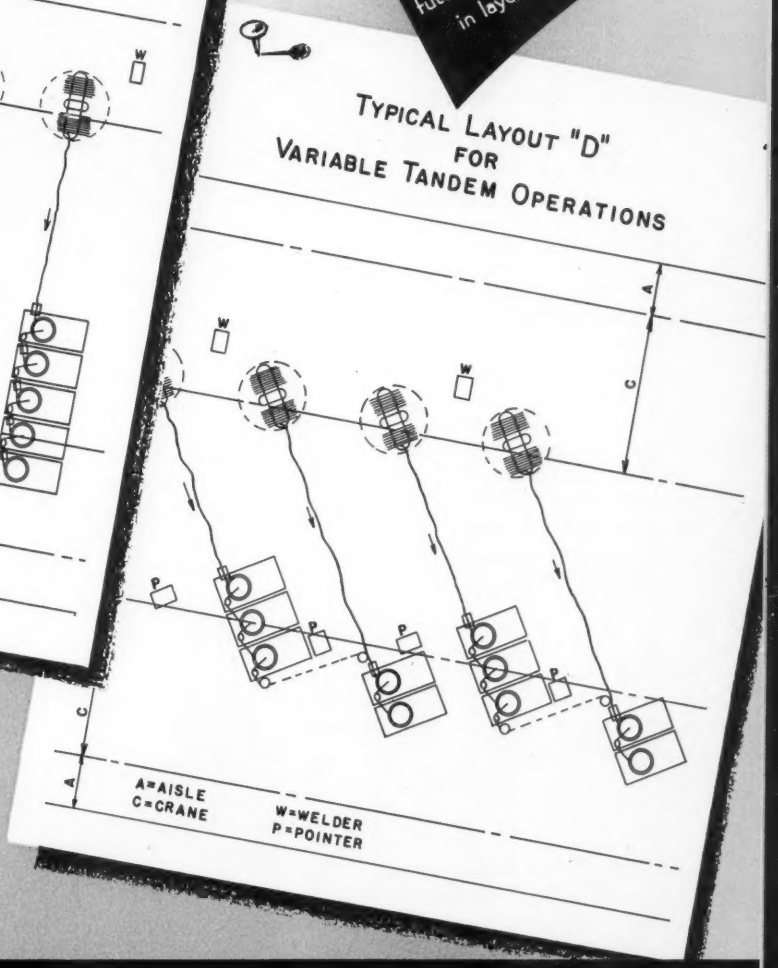

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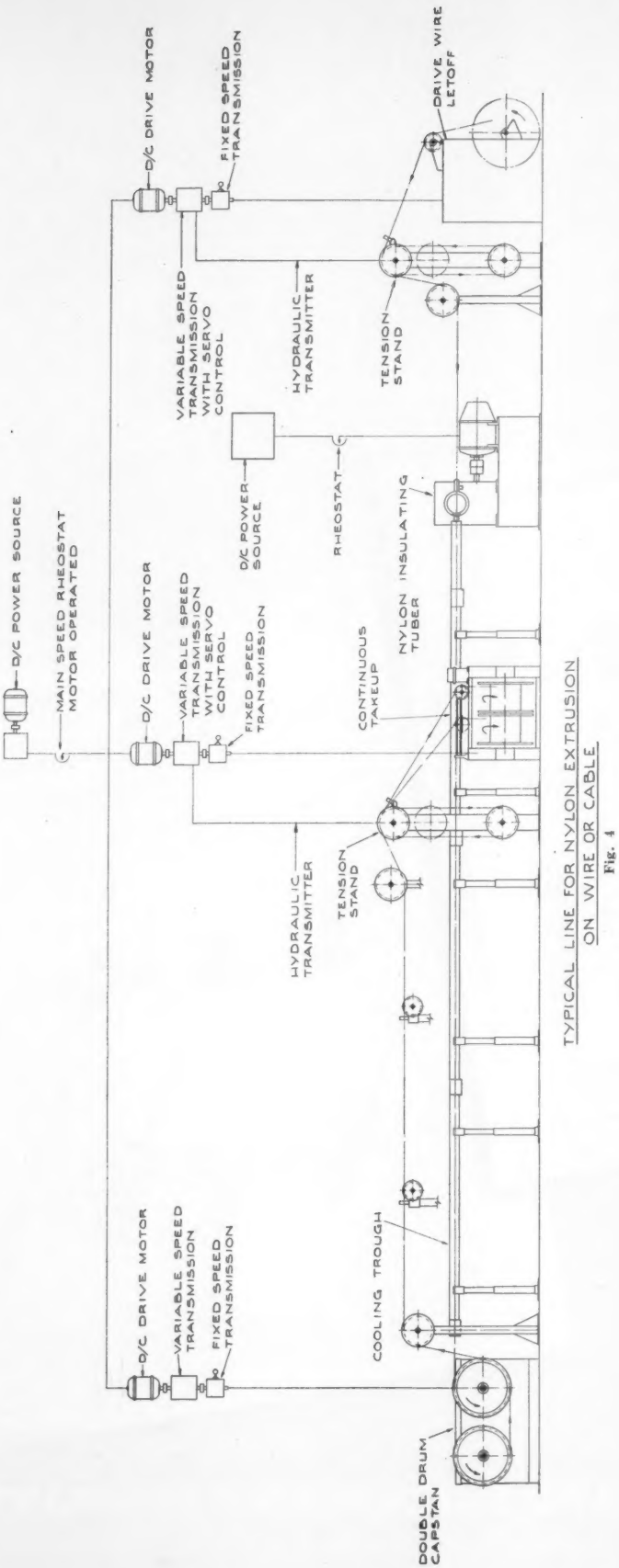


TYPICAL LINE FOR NYLON EXTRUSION ON WIRE OR CABLE

Fig. 4

The Hot Melt or Extrusion Method

THE hot melt or extrusion method of applying nylon is principally used to cover the heavier bare wires and is the standard method for jacketing large wires and cables.

★ ★ ★

IN its basic principles, it differs appreciably from the solution method, not only in the operation itself but, naturally, in the equipment required to perform this operation.

★ ★ ★

THE principal differences in the two methods are as follows:

1) **In the hot melt system, the nylon is applied hot to the conductor. In the solution method, it is applied cold to the conductor.**
2) **The hot melt system requires after-cooling to solidify the coat, while the solution method uses the heat to evaporate the solvent and polymerize the nylon material.**
3) **The hot melt method uses nylon in granular form which is then changed to a semi-fluid state in the extrusion machine. The solution method uses solvents as the vehicle for the nylon.**
4) **Adaptations of plastic extrusion equipment are used to apply hot melt nylon while enameling type tower equipment is used for the solution method.**

★ ★ ★

THE extrusion method is used on wire or cable sizes extending from the large diameter jacketed types of multiple conductor cable to approximately 24 gauge single copper conductor. The wall thicknesses may vary from .010″ thick to .050″ or .060″ thick, depending upon the specifications the cable is to meet with respect to electrical strength and abrasive resistance or other factors. The operating speed range for the normal extrusion operation runs approximately from 200 feet per minute to 2000 feet per minute.

★ ★ ★

LIKE any other extrusion operation, the wire speed depends directly upon the nylon wall thickness, the wire diameter, the extrusion machine delivery capacity in pounds of material. Heavier cable jacketing operations may go down to as low as fifty feet per minute, depending upon these same factors.

★ ★ ★

A TYPICAL nylon extrusion system for this general wire range is shown in Figure 4. This particular system has been selected from many installations because of its very efficient arrangement of basic equipment and the many desirable features that have been designed into it.

★ ★ ★

THIS complete system is driven by a complete range drive, including a variable voltage drive for the main wire speed at all of the driven components and hydraulically controlled transmissions for the reel synchronization. It also includes a synchronously driven wire letoff stand. The entire line throughout utilizes true constant tension wire handling.

★ ★ ★

THE arrangement consists of the following items:

1) **Driven Letoff Stand and Tension Control.**
2) **Nylon Extrusion Machine with Nylon Die and Tip.**
3) **Water Cooling Trough.**
4) **Wire Propelling Capstan.**
5) **Dual Continuous Takeup Machine and its Tension Stand.**
6) **Synchronous Drive.**

★ ★ ★

Driven Letoff Stand and Tension Control Unit

BECAUSE of the fact that the application of any jacket by the extrusion method requires precise tension control and because of the fact that fine wire was to be run on this line, a driven constant tension letoff stand was incorporated. This stand is driven by a synchronous drive so that the wire is paid off from the driven reel at a rate that is synchronous with the capstan speed and at constant tension. The tension on the wire is directly applied to the wire in the tension control stand.

★ ★ ★

REGARDLESS of the speed of the wire or how the wire speed may be altered through the complete range of the unit, the unwind stand is always rotating at a constantly corrected synchronous speed.

★ ★ ★

SOME nylon coating operations, especially those which are fully continuous, use a dead reel payoff stand. This method requires specially wound reels so that the ends of the wire on separate reels can be butt welded together, thereby allowing uninterrupted flow of material into the inlet side of the extruder. However, because of the difficulty of maintaining uniform tension with this method of payoff, driven reel payoff was selected. A typical driven let-off stand and tension control unit are shown in Fig. 5.

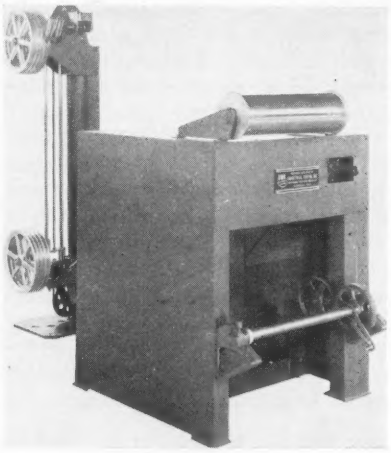


Fig. 5
Four Speed Driven Letoff and Tensioning Stand for Nylon Coating.

THE tension stand is literally a measuring device which measures the amount of wire that is being fed into it and compares it to the amount of wire that is being taken out. Inasmuch as the differences in wire taken in and taken out reflect in the position of the dancer sheave, this movement is used to control hydraulically controlled transmission which, in turn, drive the unwind stand.

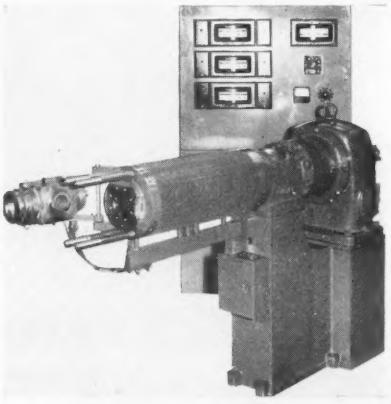


Fig. 6
Typical Nylon Insulating Tuber, Courtesy National Erie Corp.

★ ★ ★

Nylon Extrusion Machine with Nylon Die and Tip

THE nylon extrusion machines that are principally used are shown in illustrations 6 and 7. Both of these machines are typical nylon machines and are equipped with a crossfeed insulating head and with the regular nylon die system. The usual machines, used for applying nylon, are equipped with a special screw which differs in its design from the polyvinyl chloride screw. All of the tubers available are equipped with zone type electric heating so that it is quite possible to alter the extrusion temperatures quite simply. In addition, thereto, all of them are equipped with controlled electrical heating elements directly in the die holder to prevent any cooling of the nylon prior to its leaving the extrusion die.

★ ★ ★

THE conventional method of heating these machines is electric cartridge elements. However, some installations are in operation in which circulating oil and in one case in which Dowtherm is applied. The circulating oil and the Dowtherm installations incorporate some extra element of cost and danger. Accordingly, the electric heating element type of heating is almost universally used.

★ ★ ★

BOTH machines are equipped with the long barrel which is typical of the plastic insulating tuber. Variable voltage drives power the tuber screw.

★ ★ ★

IN Fig. 8 is shown a typical layout for a nylon tip and die. This drawing is a horizontal section taken through the centerline of the crosshead and the centerline of wire.

★ ★ ★

YOU will note that the end of the core tube is equipped with a vacuum line. The principal purpose of this vacuum line is to reduce the pressure around the wire and between the wire and the nylon to improve the tenacity of the nylon to the copper. Although this system is sometimes used with other materials, it is more often used with nylon.

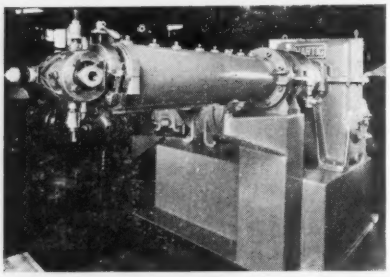


Fig. 7
Typical Nylon Tuber, Courtesy Hartig Engine & Machine Co.

★ ★ ★

IN actual practice, extreme care must be used in the design and the machining of these dies in order to prevent undo volume and abrupt flow changes in the nylon passages. Any possibility of pocketing of the material or excess space for the storage of the nylon results in either a plugged die or over-cured material. Both of these difficulties obviously cause shutdowns. The die that is shown in this drawing is a composite of a die design as provided by two different tuber manufacturers.

★ ★ ★

The Water Cooling Trough

THE water cooling trough in itself is usually a square, triangular or rounded bottom trough of sufficient length to provide for proper cooling of the nylon and the wire. Depending upon wire speed, nylon thickness and wire size, these troughs can extend from twenty feet to fifty feet in length.

★ ★ ★

THERE are several methods of actually applying the cooling water to the wire. The most used method is that which employs a quantity of water continuously maintained in the trough at a level which is over the centerline of the wire. This water level is maintained by the volume flow of water rather than through the use of any dams or weirs at the tuber end of the trough. The outlet end of the trough is equipped with a felt dam, the wire passing through a slit in that dam. Various discussions as to the efficacy of counterflow versus parallel flow water have occurred but from an overall cooling standpoint, counterflow seems to be the most efficient.

★ ★ ★

FOR heavy wire and cable, the latter half of the cooling trough is equipped with bottom rolls to assist in carrying the weight of the cable passing through. In cases of this type, the centerline of the cooling trough is usually placed one to one and one-half inches below the centerline of the extrusion die.

★ ★ ★

IN order to remove the free water from the wire, a compressed air wiper is employed in the discharge end of the cooling trough. These air wipers ordinarily run at operating pressures extending from 10 to 50 psi depending upon the volume and pressure of air required to remove the moisture.

★ ★ ★

Wire Propelling Capstan

THE capstan shown in the Fig. 9 is one that is used with any extrusion operation. Large diameter capstans should be employed for the obvious reason of minimizing the cold working of the wire, or breaking of paper or other insulations. In bare wire installations, the capstan size is of lesser importance than in the case of nylon jacketing over other types of

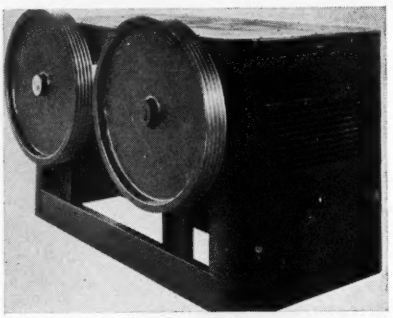
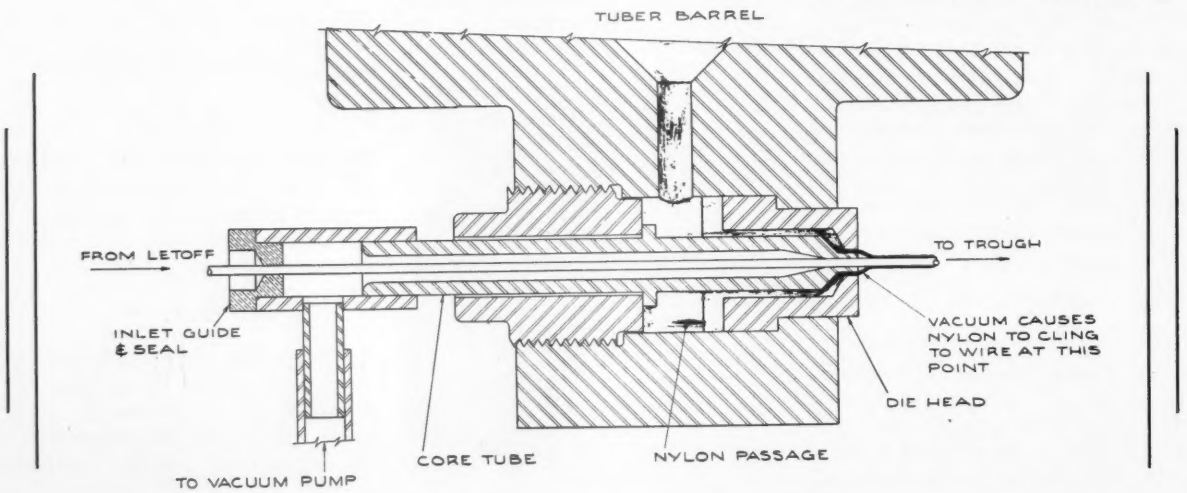


Fig. 9
Four Speed Capstan as Used on Nylon Coating.



PLAN SECTION THRU DIE HEAD
Fig. 8

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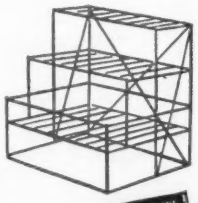

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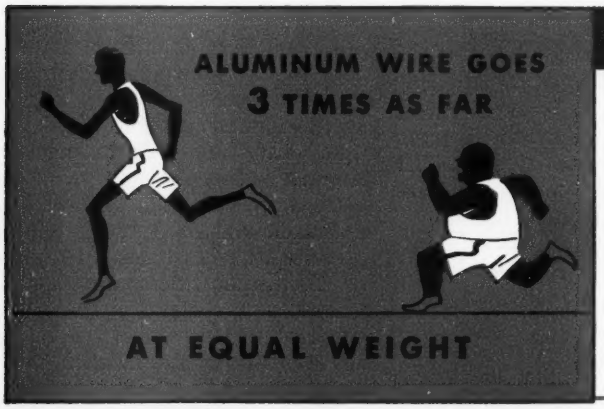

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previously insulated cables using papers or tapes. In these cases, the capstan diameter must be large to prevent breaking or kinking of this inner insulating material. This particular capstan employs a single drive on both capstan sheaves for maximum traction of the wire or cable.

★ ★ ★

BECAUSE the capstan provides the main force for the propulsion of the wire through the die, this propulsion must be as smooth as possible. Engineering care must be taken in the design of the drives propelling the capstan.

★ ★ ★

THE capstan is positioned in the line as is indicated on the drawing, in Fig. 4. There are several other locations for the capstan but the most convenient is that which is indicated.

★ ★ ★

IN the cases where space layout does not permit the full length required for the cooling trough, it is sometimes advantageous to submerge the capstans in a water trough of their own. Then the sheaves are immersed in water up to their centerlines. Systems of water spray or other means of water flooding are employed to provide maximum cooling water contact with the wire as it passes over the top half of the sheaves.

★ ★ ★

Dual Continuous Takeup Machine and Its Tension Stand

AS the speeds for the extrusion of nylon are relatively high, continuous reel takeups should be employed. A conventional takeup used for nylon is indicated in Figure 10.

★ ★ ★

IN the continuous running of the material from a full to an empty reel at the high operating speeds, it becomes important that the traverse and guide sheave system be adequately designed. The illustration indicates a compact arrangement of a double width traverse with a manual lift-over guide sheave. Automatic crossovers would accomplish this same operation without manual attention. As in many extrusion operations, automatic crossover equipment is not required.

☆ ☆ ☆

THE tension stand, which is shown adjacent to the takeup, accumulates the amount of wire that is not taken up after crossover by the empty winding reel during the time it requires for full acceleration of that reel to its proper running speed. This acceleration time is only a matter of several seconds, nevertheless, at 2000 Fpm capstan speed; the amount of wire to be handled in the accumulators amounts to 60 to 90 extra feet. The tension stand is usually counterbalanced to provide for minimum tension on the wire. Contrary

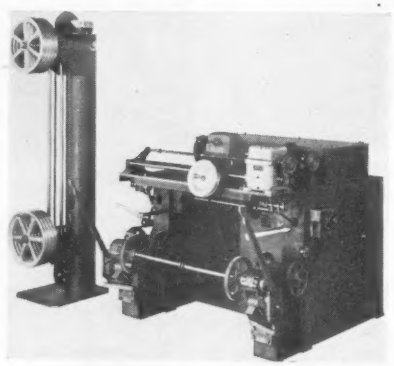


Fig. 10
Typical Continuous Extrusion Takeup Machine with Tension Stand.

to general belief, this counterbalancing cannot be done to zero tension because of the general inertia of the mechanical parts in the system. In cases where zero tension is required, other means of synchronizing must be used.

☆ ☆ ☆

Synchronous Drive

THE synchronous drive of the system is one which is rather unusual in its design. In the normal extrusion operation, the synchronized power to drive the takeup is usually transmitted from the capstan housing by means of mechanical line shafting. At the front end of the machine, the friction unwind stand is used and the wire actually does the work of driving the unwinding reel. With the fine wire sizes involved, this is an impractical solution and broken wire and generally unsatisfactory operation would result.

☆ ☆ ☆

ACCORDINGLY, in the design of the drive for this system, it was decided that the following components should be separately but synchronously driven:—

1) **The Wire Letoff Stand.**
2) **The Wire Capstan.**
3) **The Wire Takeup Machine.**

★ ★ ★

THE obvious solution to this particular problem was the utilization of a variable voltage electric system drive. Because of the wide acceptance of this type of drive in the extrusion operation, it was used in this particular case. However, in further analyzing the total speed range requirements, which extended from 50 to 1600 Fpm, it was impossible to provide a reasonably priced drive system for this speed range. Accordingly, it was decided that a combination of a variable voltage electric drive and a mechanical transmission drive with hydraulic servo control would be utilized.

★ ★ ★

THE drive system utilized is as follows:—The power to each one of the transmissions driving the three elements was supplied from the main rectifying unit to each one of the three D.C. motors. The three D.C. motors in each of the component parts of the line, in turn, drove a variable speed mechanical transmission equipped with servo hydraulic control. This hydraulic control, in turn, was operated through its range by means of hydraulic transmitters connected to the floating sheaves on the respective tension stands. As the floating sheave in each one of the tension stands altered its position, the unwinding or winding reel speed was increased or decreased to suit the new wire speed condition.

★ ★ ★

THUS, by a combination of two familiar drive systems, it was

(*Please turn to page* 964)

Planning for Wire Mill Handling

F. L. Hayden, Works Manager
Steel Company of Canada, Ltd.
Hamilton, Ont., Canada

A paper presented at the Wire Association Convention in Chicago, Ill., October 17-21, 1949.

LOW cost material handling has become a matter of prime importance in every kind of industry. The methods used vary as widely as industry itself. In continuous hot strip rolling the processing machines are also the material handling equipment which move the steel from the raw material stage to the finished article. The flour milling industry uses gravity for much of its material movement.

★ ★ ★

WHEN we ask ourselves how material should be handled in the Wire Mill the answer of course depends upon whether we are planning a new mill or improvement in the methods of an old one. It also depends on whether the material is ferrous or non-ferrous, whether the Wire Mill is adjacent to a Rod Mill and on many other factors.

★ ★ ★

IT is likely that everyone concerned with the operation of a Wire Mill has dreamed of some perfectly mechanized system where a very few people press buttons, watch lights and dials and so move the right materials to their proper destinations at the required time. For most of us that will remain a dream but we can plan for improvements in our present methods and strive for the best system applicable to the particular mill's local condition.

★ ★ ★

IF a new mill is being considered, probably the materials handling methods should first be planned and then the actual mill designed to accommodate those methods. However, most of us will naturally be concerned with improvements in existing mills and it is about the factors to be considered in planning such improvements that this paper will deal. There is no one right answer for any phase of material handling which will apply to all mills. Perhaps there is a preferred approach to the problem which if followed will provide the right answer for each mill.

★ ★ ★

FOR most of us the start in our material handling is in the Rod Storage and it is here that the success or failure of the whole handling system may be affected. Does the storage area allow for the separate stocking of all sizes and grades received and segregation of heats of the same grades and sizes. Is bin storing necessary because of the limited space. What handling facilities are required to ensure that the receiving and stocking of rods will not interfere with feeding the mill. Is the area so laid out that the heaviest tonnages have the shortest distance to travel during receiving and delivery to the mill. Can rods be moved from the storage to the Cleaning House without a great deal of labour and should this be done by means of Bridge Cranes, Gantry Cranes, Conveyors, Boom Trucks or Mill Buggies. Does the geographical location of the Wire Mill and weather conditions require covered storage.

★ ★ ★

A MOST important question in the planning for improved handling methods is the size of the bundle which can be processed through the different mill operations. The answer to this will of course depend on such factors as Cleaning House equipment, types of wire drawn, kind of wire drawing equipment used, stripping cranes, whether the wire is drawn for shipment to customers or further processing into nails, fence, stranding, etc. When it is decided what the best size of bundle will be, a further series of questions must be answered. Can the required bundle weight be obtained in the hot rolled rod. If not, should the smaller weight rod coils be welded together ahead of cleaning or at the wire drawing frames.

★ ★ ★

HOW are rods and wire to be moved through the various departments to the shipping floor. Does the building construction lend itself best to the use of overhead travel or is floor movement better. If overhead, will Bridge Cranes, Gantry Cranes or Tramrail serve best. Should floor movement be decided upon, will it be by Boom Trucks and shall these be gas or electric. Can the material be economically moved on racks or pallets or should Mill Buggies and Tractors be the method. The answers to these questions will only be soundly arrived at when we have considered head room and permissible roof or floor loading and whether or not stocks of cleaned and limed rods and process wire can be accommodated in the mill.

★ ★ ★

CAN aisles of sufficient width be provided to allow the movement of a boom truck, tractor, etc. which might be needed. Will the aisles allow right angle turns for such equipment. What should be the flooring to ensure low maintenance costs, concrete or wood blocks, expanded metal, steel plates

or the non-skid cast iron tile. Our studies toward improved handling will also consider movement through walls. Are the doors of sufficient width and height to provide clearance for the equipment which will be used. Must any of them remain closed ordinarily and if so can they be equipped with automatic openers or pull switches so placed that truck or tractor drivers can operate them from either side without having to leave their vehicles.

★ ★ ★

IF the plant has more than one floor what about ramps or elevator equipment. Is there sufficient room to allow ramps with a grade negotiable by handling equipment. Have the elevators capacity to handle the heaviest piece of equipment planned when it is fully loaded. Can the elevators be equipped with automatic operation and floor levelling devices, the latter being necessary to prevent lost time in jockeying to the right stop and excessive floor maintenance.

★ ★ ★

AFTER it has been decided what kind of equipment will be used we must consider whether or not it should all be of the same manufacture. The answer to this will have considerable effect on future maintenance costs, the training of operators and assurance that vital machines will not be idle because some member of the crew may be absent. When our planning seems to have been completed it would be well to go back over each step and make sure that there will be some alternative method of moving material in case of machine breakdown or other happenings.

★ ★ ★

MOST of our wire manufacture is carried out according to laid down practices or specifications established in the particular mill or the industry generally. This has been found necessary to ensure that the required products will consistently perform as required for their end uses. For the same reason it is well to lay down practices for the use of material handling equipment and everyone concerned with the operation of this equipment should be familiar with the best methods for its use.

★ ★ ★

THE most perfectly designed handling system is only right for the conditions for which it was planned. These conditions will change due to the installation of new equipment, alterations to buildings, changed layouts in departments as well as the introduction of new lines of products. Therefore, it is well to provide for periodic reviews of handling methods.

★ ★ ★

ALTHOUGH it is likely that all the preceding points will be important factors in any mill, they will not cover everything which should be considered for any particular mill. Full consideration of these points and those peculiar to the particular mill should result in a handling system which will satisfactorily achieve the objective of economical material movement in the Wire Mill.

★ ★ ★

THE INDUSTRIAL APPLICATIONS OF DIAMONDS

An Exhibition Open to Members of the Wire Association Attending the Annual Convention at the La Salle Hotel.

Exhibition opens at 5 P.M., Tuesday, October 18th, in the Reception Room adjoining the Convention Meeting Room and will remain open until 2 P.M., Thursday, October 20th.

On Tuesday evening, October 18th, starting at 8:30 P.M., a one-hour show will be presented, comprised of the following:

A short talking film on diamonds—"The Eternal Gem."

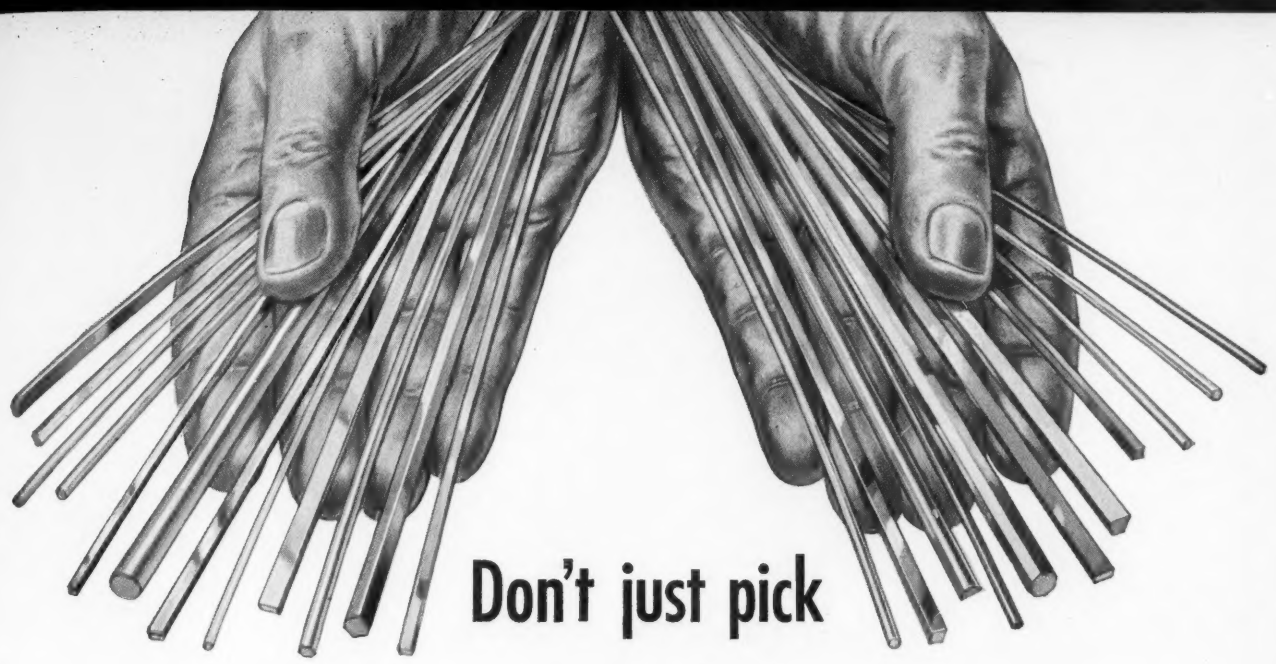
A popular discourse: "The Industrial Diamond, Its Products and Its Service to the People" — by A. D. Leveridge, Executive Manager, Industrial Diamond Ass'n of America.

The audience will be invited to inspect the displays and to ask questions.

You are cordially invited to attend.

THE WIRE ASSOCIATION

Richard E. Brown, Executive Secretary



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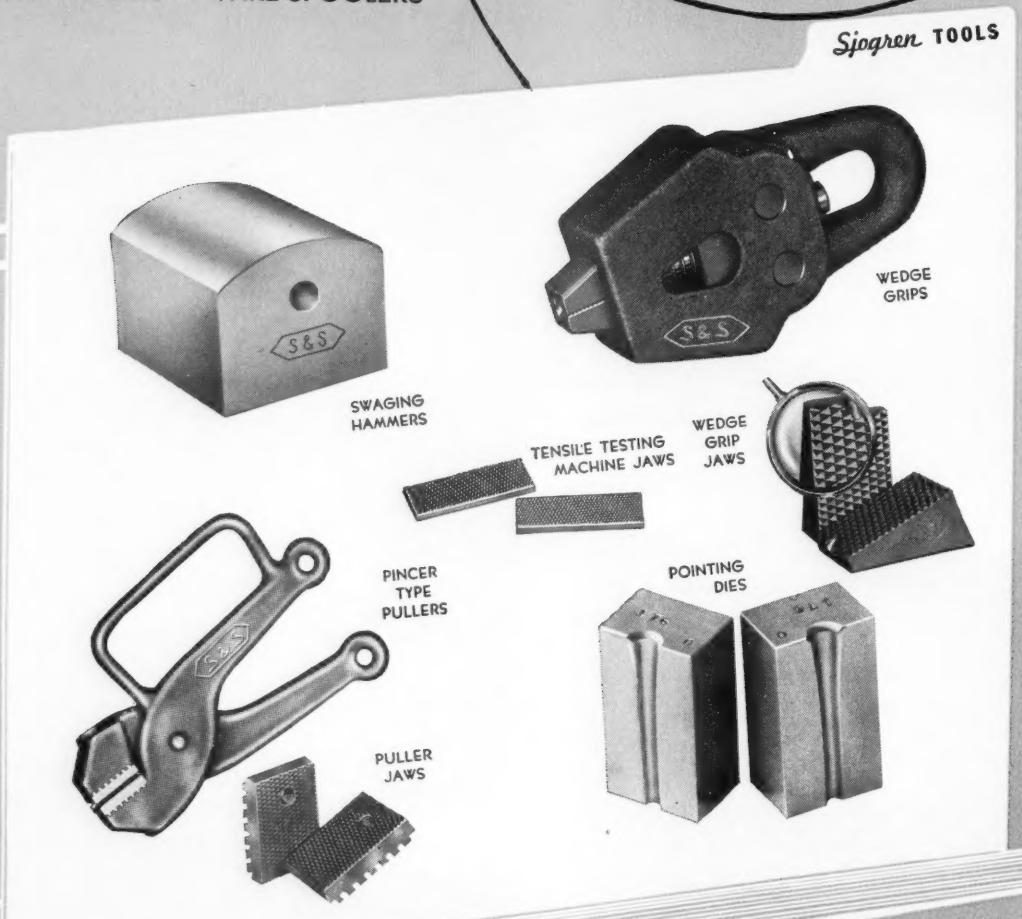

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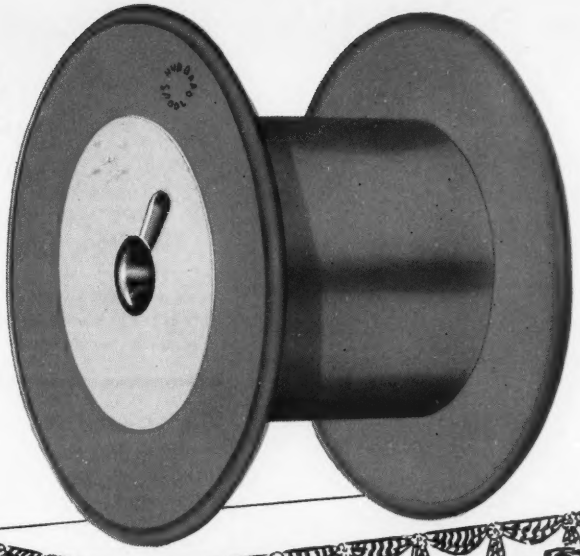

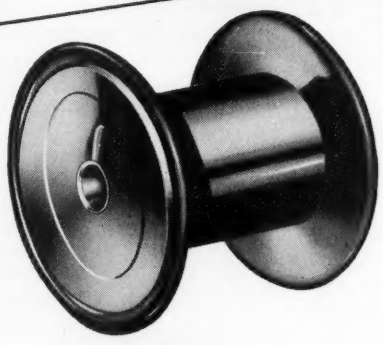

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Possibilities in Handling Wire and Wire Products

By J. W. Galloway, Plant Engineer
The B. Greening Wire Company, Ltd.
Hamilton, Ontario, Canada

A consideration of more efficient material handling methods — presenting some ideas for discussion.

MORE and more interest is being shown in the problem of handling. We have always had to handle goods in the raw, the semi-finished and finished state. When the hourly rate of the humble day labourer was considerably less than it is now we didn't worry very much about handling and labour saving handling schemes. To-day there is no such thing as a humble day labourer and the hourly rate being paid makes everyone handling conscious. This is a healthy condition for now we have to do things that should have been done long ago. We all have much to learn and everyone can contribute. Fortunately this is a subject that need not be put on the hush hush list.

★ ★ ★

NECESSITY coupled with new tools has always increased production and lowered costs. The introduction of carbide dies not only made possible but forced a change in the design of our equipment. Is it too much to think that "Handling" properly studied and applied can cause a similar change, with a far reaching benefit to all? Every issue of a trade publication shows some new handling tool. It is only reasonable to expect that other new tools will be supplied to us as fast as we lay down new specifications.

★ ★ ★

LET us look at how we have been handling materials in the Wire Mill and how we might better do the job. At the present time we receive our rods in coils of about three hundred pounds. Often as not these coils reach us in anything but a good package. When the coils were about half the present size they were man-handled to storage and in some cases still are. The general practice, however, is to pick up a sizable number of coils on a hair pin hook and pile them in storage bins or racks. In a similar manner the rods are taken from storage to the Cleaning House. In some smaller mills a yard crane on wheels takes the place of the more expensive and more efficient over-head handling installation. We haven't done too badly a job here, but there is still plenty of room for improvement. This is especially true of the package with which we start out.

★ ★ ★

THE modern cleaninghouse operation is one place where handling has been studied and pretty well stream-lined. The so called "Straight Line" system of cleaning has been pretty well covered and is familiar to all. However, I think we all have unsolved problems as how to best handle the materials used in the cleaning process. With the mechanical handling used in the cleaning house it is an easy matter for one man to handle loads of several thousand pounds. These same loads are also being easily handled to the draw bench. Unfortunately they are made up of several small packages which to be economically drawn, must be welded together. In some cases these small coils are welded together before being cleaned. This is certainly a step in the right direction, but it seems a waste to have to do all this welding.

BIOGRAPHY

James W. Galloway was born in Holdrege, Nebraska, January 13th, 1895. He graduated from the University of Nebraska, 1917, with degree of B.Sc. in Mechanical Engineering. After graduation he spent the next twelve years in the Automotive Engineering field. In 1929 he became Chief Engineer at The B. Greening Wire Company, Ltd., and has been in charge of their Engineering, Maintenance and Development Work since. He is a member of A.S.M.E. and A.S.M. and of the Wire Association.

★ ★ ★

THE present day rod bench is capable of producing wire in unit packages far in excess of our ability to handle them, yet we procure wire from them in quite small packages. The producers of copper wire take much larger packages from all of their heavy drawing machines than do the producers of steel. True some mills are drawing one thousand pound coils on the rod benches. While this loads the finishing block to the limit of safety, the coils are still far smaller than the spools from the copper machines. There is no question but what we have all thought of the possibility of drawing steel on spools. In some cases there is a good reason for not doing so, but I think the biggest reason we do not is our fear of breaking into the unknown. Maybe a little mutual encouragement would help one of us to break with tradition after which we would all follow like sheep.

★ ★ ★

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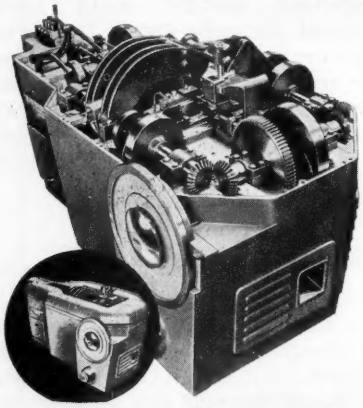
The machine can handle non-ferrous wire up to 0·080″ dia. and steel wire up to 0·064″ dia. There's also a model for producing completed chain at the rate of 12,000 links per hour.



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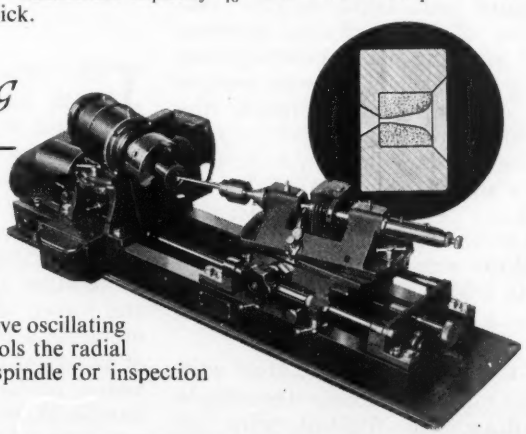

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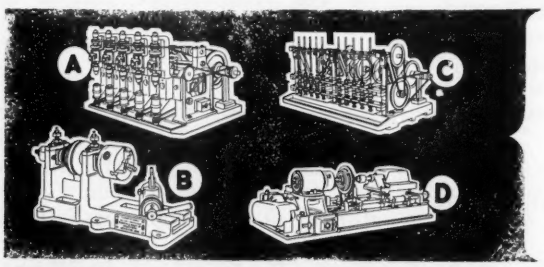
FINE or coarse parallel bores, precise tapers, angles and radii are all produced faster and automatically on this machine. It has a high rate of carbide removal and bores angles and radius operations in one setting. The unique positive oscillating device is adjustable for pressure, a quick-acting clutch controls the radial head and the headstock can be swung clear of the needle spindle for inspection and hand polishing. Available with 4″ and 8″ chucks.



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spools. Has this been proved to be true or false? I for one wish I knew the answer. At any rate there is a lot of wire drawn where this is not a governing factor. Handling wire on large spools would certainly simplify inter-process handling and storage also. If we could double the size of our present package to and from the wire drawing machines, wouldn't it be logical to expect that one operator could run twice the number of machines. We certainly have mechanical handling equipment available to do the job required.

★ ★ ★

IT can't be denied that the larger the package the less the man hour requirements will be once we go to planned mechanical handling. At present we strip a coil of wire from the finishing block and tie it up. The coil is then transferred to a skid or buggy. This skid load of wire eventually goes to the intermediate machine, assuming it is low carbon, and is further drawn without annealing. I say eventually because it may first go to storage and be unloaded then reloaded and taken to the machines. This is certainly unnecessary handling but it is being done every day. When the wire reaches the next drawing operation the tie wires are removed and the coils loaded one at a time unto the pay-off stand. Quite a bit of work isn't it? This business of loading and unloading goes on all the way until the wire is ultimately shipped in its final form.

★ ★ ★

IN the drawing of fine steel wire the step has already been made to draw the finished wire on spools. Several years ago the possibility of doing this was contemplated and we discussed the problem with other wire mill men. There was considerable fear that bad wire would be buried in the spool. There was also fear that the wire drawers would bury breaks. There was also the question of inventory in spools. Strange to say none of our fears have materialized. I have heard of one mill where fine wire is spooled that the men demand a premium for drawing wire in coils. The savings in handling have outweighed the heavy inventory in spools. Material savings have also been made in our weave mill using spooled wire in place of the conventional eight inch coil.

★ ★ ★

I HAVE spoken of the size of package in handling but this is only one of the phases of handling. As the cost of handling makes up a large percentage of the cost of producing wire we must study ways and means of eliminating every unnecessary step. Mechanical handling has removed, to a large extent, the limitation of weight of package. As we plan for economical handling we automatically bring out new requirements in machines and grouping of machines, with corresponding savings in machine operation costs. It is my hope that we may have a free and open discussion of the many phases of handling. We all have problems and some of us must have some of the answers. This is a problem we all have and I feel sure the best way we can help ourselves is by helping others.

★ ★ ★

THE company I am with has a small mill compared to most mills and we are not able to do things on a large scale. We do, however, make a very diversified range of materials including practically all metals and alloys, with the exception of high carbon steel. In addition we fabricate wire rope and woven wire fabrics. Thus our problems are some of the problems of practically all of you, with the added problem that we have to handle in small volumes. We are and have been going through a series of plant expansions and modernizing and some of our problems and what we have done may be of some interest to you.

★ ★ ★

IN the Wire Mill one of our problems has been how best to get our wire rods onto our cleaning yokes. The tonnage of rods through our Cleaning House is not sufficient to take much more than half the time of one man. As this man has spare time available we will have him weld the individual coils together to form a 3000 pound package ready for cleaning. The 3000 pound coils will be loaded onto a transfer skid, one coil at a time, and welded to form the finished package of 3000 pounds. The over-head crane of the Cleaning House will then pick up the 3000 pounds of wire in one piece and clean, lime and bake them in the conventional manner. After baking the rods will again be placed on the transfer skid. The transfer skids will then be moved under two lines of over-head monorail. From here the 3000 pound package will be picked up by an over-head hoist on a combined hair pin hook and flipper. The loaded hook will then be placed on a rack and the wire flipped in the regular manner to the rod machine. An over-head system could have handled the rods direct from the cleaning to the rod frame but for our particular production this was not deemed advisable. Another method equally sound under certain conditions would be a ram lift truck.

★ ★ ★

THE next question was how best to tie in the rod frames with the intermediate frames as there is no annealing between the two. Should one man run two rod frames or should one man run a rod frame and a group of intermediate frames? From a handling angle it is simpler to group the rod frame with the intermediate frames. If the two rod frames are run by one operator and the intermediate frames by others, then the wire would have to be tied in bundles, loaded on skids, weighed, delivered to the intermediate frames and loaded on the pay-off stands.

★ ★ ★

BY grouping the rod and intermediate machines together the operator is paid on wire finished on the intermediates only. Thus the wire does not need to be weighed between the two operations. The overhead handling is such that the wire, as stripped from the rod frames, can be taken

(*Please turn to page* 966)

PROGRAM

Annual Convention of The Wire Association

La Salle Hotel, Chicago, Ill., October 17-21, 1949

Wire Association Headquarters at The La Salle Hotel
Will be Open from Monday, October 17, Every Evening During the Convention
— Come and Get Acquainted!

THERE WILL BE A REGISTRATION FEE OF $5.00 FOR THOSE ATTENDING THESE TECHNICAL SESSIONS AND INFORMAL MEETINGS

ADMISSION WILL BE BY BADGE ONLY

Discussions Will Be Held on the Papers Presented and These Discussions Will Be Published in the January, 1950, Issue of Wire and Wire Products

WIRE ASSOCIATION PROGRAM COMMITTEE FOR 1949 CONVENTION

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La Salle Hotel, Chicago, Ill., Oct. 17-21, 1949
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★ ★ ★

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RESERVATIONS AND REGISTRATION

Mrs. Ruth S. Spengel, Secretary and Treasurer
WIRE AND WIRE PRODUCTS
300 Main St., Stamford, Conn.

All wire mill men and suppliers are invited to attend this meeting, see how the Association functions and participate in the activities.

Papers selected are preprinted in Wire and Wire Products October 1949 issue in advance of the meeting. Title to papers accepted will be given the Wire Association and duly copyrighted at time of publication. All papers are eligible for consideration for the Annual Medal Award.

Hotel reservations should be made by members of the Wire Association direct to the Secretary.
MAKE YOUR PLANS NOW TO ATTEND AND SEND YOUR RESERVATION PROMPTLY

MONDAY, OCTOBER 17

9:00 A. M.
REGISTRATION

10:30 A. M.
DIRECTORS' MEETING

12:30 P. M.
PROGRAM COMMITTEE LUNCH

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★ ★ ★

PAST PRESIDENTS

Ralph K. Clifford, President,
Continental Steel Corp., Kokomo, Indiana

F. A. Westphal, Division Manager,
Sheffield Steel Company,
Sand Springs, Oklahoma

D. D. Buchanan, Manager of Operations,
Union Drawn Steel Div.,
Republic Steel Corp.,
Massillon, Ohio

R. M. Hussey, Superintendent Wire Dept.,
Jones & Laughlin Steel Corp.,
Aliquippa, Pa.

J. K. Beeson, Vice-President,
Pittsburgh Steel Co., Pittsburgh, Pa.

Carl E. Johnson, Superintendent,
Rod & Wire Mills, Bethlehem Steel Co.
Sparrows Point, Md.

THE Wire Association is a non-profit organization of wire mill executives, superintendents and foremen. It also includes plant engineers, traffic men, and all others engaged in the production of cold drawn bars, rods, wire, strip, insulated wire and cable, and the manufacture and fabrication of finished wire products, including cold headed, extruded and other cold worked metal products.

THERE are separate divisions for all the separate major interests in the wire industry, steel, iron, brass, copper, alloy, and precious metals, together with divisions relating to drawing, cold working, cold heading, extruding, fabricating, forming, spring making, wire cloth, wire rope, bare and covered electric wire and cable and all other forms of wire and wire products.

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PURPOSES

ITS specific purpose is to improve production methods and afford a clearing house for ideas on management problems, technical problems, and research work in all phases of practical wire drawing and wire working, and to develop and maintain friendly relations among the members.

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ACTIVITIES

The Association functions along the following lines:

1. The use of the Association headquarters as a central clearing house for information and data of all kinds which may be of interest to members.
2. The exchange of ideas on processes of production including machinery, technical processes, etc.
3. The establishment and maintenance of friendly relations among the members of the association and the development of sectional and national meetings to discuss matters of mutual interest.
4. Studies of production methods and analysis of production costs.
5. Developments in the use of new materials and new applications of existing materials and by-products.
6. Research and collection of information on personnel management, including such factors as labor turnover, seasonal changes in the demand for employees, wage scales, etc.
7. Standardization and simplification as a means for the effective elimination of waste.
8. Such other subjects as may be determined upon.

THE WIRE ASSOCIATION MEDAL AWARDS

For the Most Meritorious Paper on Wire Manufacture or Fabrication During the Year
— BY A MEMBER OF THE WIRE ASSOCIATION —

MEDAL AWARDS

1934 — EDWARD J. P. FISHER
Metallurgist, Keystone Steel & Wire Co., Peoria, Ill.
Title of Paper: "COLD DRAWN STEEL SPRING WIRE"

1935 — BENJAMIN LEWIS McCARTHY
Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper: "GRAIN SIZE AND ITS INFLUENCE ON THE MANUFACTURE OF STEEL WIRE"

1936 — ROBERT NOTVEST
Chief Engineer, Welding Division, J. D. Adams Mfg. Co., Indianapolis, Ind.
Title of Paper: "STEEL FOR ARC WELDING ELECTRODES"

1937 — BENJAMIN LEWIS McCARTHY
Chief Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper:
"ABNORMAL GRAIN GROWTH AND THE ANNEALING OF LOW CARBON STEEL WIRE"

1938 — WALTER R. BLOXDORF
Metallurgist, The MacWhyte Co., Kenosha, Wis.
Title of Paper: "WIRE ROPE"

1939 — STANLEY P. WATKINS
Manager, Sales Development, Rustless Iron and Steel Corp. Baltimore, Maryland
Title of Paper:
"THE MANUFACTURE AND USE OF STAINLESS STEEL WIRE"

1940 — ROBERT W. SANDELIN
Metallurgist, Atlantic Steel Company, Atlanta, Georgia
Title of Paper:
"GALVANIZING CHARACTERISTICS OF DIFFERENT TYPES OF STEEL"

1941 — CARLETON W. GARRETT
Wire Mill Metallurgist, Jones & Laughlin Steel Corp. Aliquippa, Pennsylvania
Title of Paper:
"A BRIEF DISCUSSION ON THE MANUFACTURE OF STEEL FOR ARC WELDING ELECTRODES"

1942 — LE ROY DEVOE SEYMOUR
Asst. Works Manager, Canada Works, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada
Title of Paper:
"SCHEDULING AND PLANNING THE WIRE MILL FOR WAR PRODUCTION"

1943 — JOHN C. AIKEN
Asst. Supt., Rod and Wire Mills, Jones & Laughlin Steel Corp., Aliquippa, Pennsylvania
Title of Paper: "DRAWING HIGH SPEED ROPE WIRE"

1944 — AUGUST R. ZAPP
Manager, Carbide Division, Firth-Sterling Steel Company, McKeesport, Pa.
Title of Paper:
"HISTORY AND GROWTH OF THE TUNGSTEN CARBIDE DIE"

1945 — MATTHEW J. DONACHIE
Technical Director of Production, Beryllium Corporation, Reading, Pa.
Title of Paper:
"SOME TRAITS AND CHARACTERISTICS IN THE WORKING OF BERYLLIUM—COPPER WIRE"

1946 - 1947 — No awards

1948 — REGINALD S. BROWN
Chief Metallurgist, Rylands Brothers, Ltd.
Warrington, England
Title of Paper: "WEAR RESISTANCE OF WIRE FOR ROPE WIRE"

HONORABLE MENTIONS

1935 — L. D. SEYMOUR
Metallurgist, Rod and Wire Dept., Youngstown Sheet & Tube Co., Youngstown, Ohio
Title of Paper: "COLD HEADING WIRE"

1935 — R. A. SCHATZEL
Superintendent, General Research Laboratories, General Cable Corp., Rome, N. Y.
Title of Paper: "HARD AND SOFT COPPER WIRE"

1936 — BENJAMIN LEWIS McCARTHY
Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper: "PLASTIC DEFORMATION IN WIRE DRAWING"

1937 — ROBERT W. SANDELIN
Metallurgist, Atlantic Steel Co., Atlanta, Ga.
Title of Paper:
"A METALLURGICAL STUDY OF THE FACTORS AFFECTING THE QUALITY OF GALVANIZING"

1937 — ALAN B. DOVE
Chemical Engineer, Canada Works, The Steel Company of Canada, Ltd., Hamilton, Ont., Canada
Title of Paper:
"A. C. ELECTRO PICKLING—A BETTER METHOD OF PICKLING"

1938 — RODMAN R. TATNALL
Metallurgist, Morgan Works, Spencer Steel Co. Worcester, Massachusetts
Title of Paper: "RESILIENCE OF SPRINGS"

1939 — JOSEPH A. DOYLE
Vice President, W. S. Rockwell Co., New York, N. Y.
Title of Paper: "HEATING COPPER WIRE BARS"

1940 — H. BLOUNT and J. D. WILTRAKIS
Mfg. Engineer, Point Breeze Works, Engineer, Kearny Works, Western Electric Company
Title of Paper:
"DESIGN AND OPERATION OF A NEW COPPER WIRE DRAWING PLANT"

1941 — RODMAN R. TATNALL
Metallurgist, Morgan Works, Wickwire Spencer Steel Co., Worcester, Massachusetts
Title of Paper:
"TIME, TEMPERATURE AND SIZE IN THE HEATING OF STEEL WIRE"

1942 — COLONEL FRANK W. BULLOCK
Signal Corps, United States Army
Title of Paper: "THE WIRE INDUSTRY IN WAR"

1943 — E. J. CRUM
General Foreman, Bethanizing and Galvanizing Departments, Bethlehem Steel Company, Sparrows Point, Md.
Title of Paper:
"THE GRAPHICAL SOLUTION OF WIRE MILL MATHEMATICAL PROBLEMS"

1944 — FERNALD S. STICKNEY
Vice President and Chief Engineer, Instrument Specialties Company, Little Falls, N. Y.
Title of Paper: "MAKING 'SPRING-GRADE' BERYLLIUM COPPER WIRE"

1945 — RALPH C. ELLAMS
Supervisor, Electrical Coating Development
Roxalin Flexible Finishes, Inc., Elizabeth, N. J.
Title of Paper:
"SUCCESSFUL FINISHING OF ELECTRICALLY INSULATED WIRE AND CABLE"

1945 — D. A. SUTCH, Metallurgist, and B. L. McCARTHY, Chief Metallurgist, Wickwire Spencer Steel Co., Buffalo, N. Y.
Title of Paper:
"REDUCTION OF AREA VALUES AS A GUIDE TO PATENTING"

1946 — No awards
1947 — No awards

1948 — C. A. ZAPFFE, Consulting Metallurgist and M. E. HASLAM, Research Chemist
Baltimore, Md.
Title of Paper:
"EVALUATION OF PICKLING INHIBITORS FROM THE STANDPOINT OF HYDROGEN EMBRITTLEMENT"

1948 — CHRISTIAN WITTEVELD
Process and Development Engineer, Bridgeport Brass Company, Bridgeport, Conn.
Title of Paper: "BRASS WIRE PROCESSING"

— The Technical Sessions —

La Salle Hotel, Chicago, Ill., October 17-21, 1949, Inclusive

MONDAY, OCTOBER 17
Morning Session—11 A. M.

A. F. Anjeskey
Sales Manager
Chairman of Meeting

Cleveland Tramrail Div.
Cleveland Crane & Eng. Co.
Wickliffe, O.

PAPER:
"Planning for Wire Mill Handling"

F. L. Hayden
Works Manager

Steel Company of Canada
Hamilton, Ont., Canada.

PAPER:
"Possibilities in Handling Wire & Wire Products"

J. W. Galloway
Chief Engineer

B. Greening Wire Co., Ltd.
Hamilton, Ont., Canada.

MONDAY, OCTOBER 17
Afternoon Session—2 P. M.

Curtis Voigtlander
Supt. Wire Mill
Chairman of Meeting

Union Wire Rope Corp.
Kansas City, Mo.

PAPER:
"Plastic Strain & Hysteresis in Drawn Steel Wire"

R. S. Brown
Chief Metallurgist

Rylands Brothers, Ltd.
Warrington, England.

PAPER:
"Back Pull Wire Drawing"

H. J. Godfrey
Development Engineer and
Dartrey Lewis
Chief Development Engineer

John A. Roebling's Sons Co.
Trenton, N. J.

TUESDAY, OCTOBER 18

THERE WILL BE A PLANT INSPECTION

TRIP TO

The Joliet Mills
American Steel & Wire Company

Luncheon will be served at the plant by courtesy of The American Steel & Wire Company

Busses leave La Salle Hotel 8:30 A. M.—No private cars allowed.

WEDNESDAY, OCTOBER 19
Morning Session—10:00 A. M.

E. J. Crum
General Foreman Wire Drawing
Chairman of Meeting

Bethlehem Steel Corp.
Sparrows Point, Md.

— SYMPOSIUM ON TUNGSTEN CARBIDE DIES —

Walter Schofield, Die Service Engineer
Carboloy Co.
Detroit, Mich.

E. A. Henry
Die Engineer
Vascoloy-Ramet Corp.
Chicago, Ill.

E. R. Duthaler
Jones & Laughlin Steel Corp.
Aliquippa, Pa.

E. T. Miller
Sales Eng. Dept.
Firth Sterling Steel & Carbide Corp.
McKeesport, Pa.

George Fecsen
Pittsburgh Steel Corp.
Pittsburgh, Pa.

Art Hedman
Wickwire Spencer Steel Div., Colorado Fuel & Iron Corp.
Buffalo, N. Y.

WEDNESDAY, OCTOBER 19
1:00 P. M.

WIRE ASSOCIATION LUNCHEON—
THE MORDICA MEMORIAL LECTURE

Lt. Col. Allan B. Dove,
Superintendent
Dominion Works
Steel Company of Canada, Ltd.
Lachine, Quebec, Canada

Title: "The Corrosion of Steel and Its Protective Metal Coatings"

— Presentation of the Wire Association Medal Award for 1948 —
To Reginald S. Brown, Rylands Brothers, Ltd., Warrington, England.
(Members are at liberty to bring guests. Ladies are welcome)

— The Technical Sessions —

La Salle Hotel, Chicago, Ill., October 17-21, 1949, Inclusive

WEDNESDAY, OCTOBER 19
4:00 P. M.

Annual Meeting of the Wire Association
L. D. Seymour, President
Chairman of Meeting

WEDNESDAY, OCTOBER 19
Evening Session—7:00 P. M.

ANNUAL DINNER - SMOKER — HOTEL LA SALLE
Eber Hubbard, Jr., Vice President
Hubbard Spool Company, Chicago, Ill.
Chairman of Committee

THURSDAY, OCTOBER 20
Morning Session—10:00 A. M.

	R. S. Simmons General Metallurgist Chairman of Meeting	Keystone Steel & Wire Co. Peoria, Ill.
PAPER: "Continuous Cleaning"	by D. L. Doty Supervisor—Inspection Div.	Jones & Laughlin Steel Corp. Aliquippa, Pa.
PAPER: "Processing of Stainless Steel Wire"	by S. P. Watkins Asst. to Gen. Mgr.	Armco Steel Corp. Baltimore, Md.
PAPER: "Welding in the Wire Industry"	J. H. Corson Metallurgist	John A. Roebling's Sons Co. Trenton, N. J.

THURSDAY, OCTOBER 20
Afternoon Session—2:30 P. M.

SYMPOSIUM ON DIAMOND DIES

Athos D. Leveridge,
Executive Manager,
Chairman of Meeting

Industrial Diamond
Association of America, Inc.
New York, N. Y.

This session will consist of a paper open to discussion and this paper will be accompanied by slides and motion pictures. A panel of four diamond die men will then undertake the discussion and four representatives of mills will participate in the questions and answers. A further general discussion will then be open to all in the audience. There will be an exhibit of industrial diamonds and wire drawing dies and their application with attendants prepared to answer technical questions as they may arise in connection with the exhibit.

FRIDAY, OCTOBER 21
Morning Session—10:00 A. M.

	D. Boyd Metallurgist Chairman of Meeting	Wire & Cable Div. Northern Electric Co., Ltd. Montreal, P.Q., Canada.
PAPER: "Spools for Shipping Magnet Wire"	F. A. Rappelyea Chief Engineer	Hubbard Spool Company Chicago, Ill.
PAPER: "Magnet Wire Plant—Fort Wayne Works—General Electric Co."	F. A. Arnold Metallurgist	General Electric Company Fort Wayne, Ind.

FRIDAY, OCTOBER 21
Afternoon Session—2:00 P. M.

	Dr. Bruce W. Gonser Research Supervisor, Non-Ferrous Metallurgy Chairman of Meeting	Battelle Memorial Institute Columbus, Ohio.
PAPER: "Protective Atmospheres for Annealing Non-Ferrous Wires"	E. G. deCoriolis, Dir. of Research and Orville E. Cullen, Chf. Metallurgist	Surface Combustion Corporation Toledo, O.
PAPER: "New Development in the Tinning of Wire"	Herbert Hirschland Research Department	Metal & Thermit Corp. New York, N. Y.
PAPER: "The Nylon Coating of Wire"	C. A. Litzler Chief Engineer	Industrial Ovens, Inc. Cleveland, O.

RESEARCH PAPERS ARE PREPRINTED IN THE OCTOBER ISSUE OF WIRE AND WIRE PRODUCTS
The Discussions and the Mordica Memorial Lecture will be printed in the January, 1950, issue of Wire and Wire Products

Papers not received in time for preprinting will be published in the November and December issues of Wire and Wire Products

It's New!

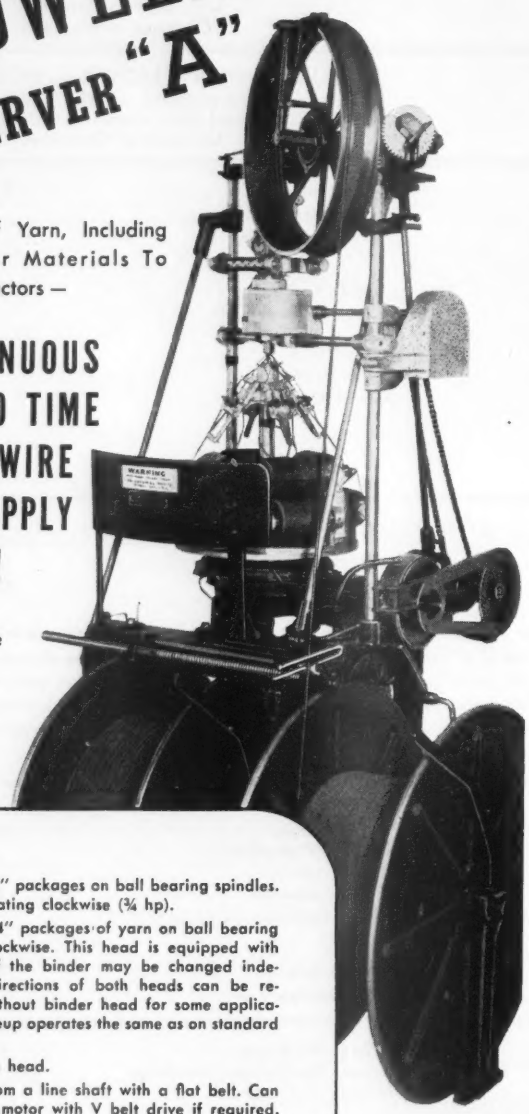
WARDWELLIAN®

YARN SERVER "A"

Applies Multiple Ends of Yarn, Including Glass Fibre and Other Materials To Electrical Conductors —

SERVES CONTINUOUS LENGTHS . . . NO TIME LOST CUTTING WIRE TO DON NEW SUPPLY PACKAGES!

Here is the answer to the demand for a flexible type serving machine for wire and cable.



Features Include:

A main head carrying eight 4" packages on ball bearing spindles. Head driven at 500 rpm, rotating clockwise (¾ hp).

A binder head carrying two 4" packages of yarn on ball bearing spindles, rotating counter clockwise. This head is equipped with change gears so that lay of the binder may be changed independently of main head. Directions of both heads can be reversed. Can be furnished without binder head for some applications. Supply windup and takeup operates the same as on standard Wardwell Braider.

Electrical stop-motion on each head.

Equipped for transmission from a line shaft with a flat belt. Can be furnished with individual motor with V belt drive if required.

Maximum material diameter applicable is ⅜".

Use The Wardwellian Yarn Server "A" for covering:

Type R wire in smaller sizes.

Building or code No. 14 to No. 4.

S. J. Cords

Telephone color cord for identification or any wire where a double serve jacket is used.

COMPLETE DETAILS ON REQUEST!

WARDWELL BRAIDING MACHINE CO.

Central Falls Rhode Island, U. S. A.

Military Procurement Information Office

A **MILITARY Procurement Information Office** to provide a central directing service to businessmen seeking contracts with the military services was opened recently in the Pentagon, near Washington, D. C. The new center is located in Room 3-D-773 near the River entrance. The phone number is REpublic 6700, extensions 75321, 75322, and 75323.

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THE new office, which is staffed by representatives of the Army, Navy and Air Force, was established at the direction of Secretary of Defense Louis Johnson as a guide service to businessmen. Its chief function will be to direct businessmen to the appropriate offices in the Army, Navy, or Air Force which may be in the market for their products or services. The center will not assist in obtaining contracts but will be of primary value to concerns which are not accustomed to doing business with the armed services.

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"British Standards"

HANDBOOK No. 10, the 1949 Edition, entitled **"British Standards for Steel and Steel Products,"** was recently published by the British Standards Institution, 24/28 Victoria Street, Westminster, London, S. W. 1.

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THE Handbook is comprised of 674 pages of information broadly falling into three divisions: (1) Articles describing the manufacture of steel and steel products; (2) Summaries of the essential technical requirements of British standards for steel and steel products; and (3) Other information of general interest, such as methods of testing, heat treatment definitions and conversion factors.

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NINE pages are devoted to wire and wire products, covering wire drawing, heat treating, dies, gauges, tests, inspection, uses and so forth. The book is priced at 25/.

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DuPont Combines Plastics and Ammonia Departments

THE DU PONT COMPANY combined its Plastics and Ammonia Departments into a single industrial department effective October 1, it has been announced.

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THE company said that the activities of the two departments have become more and more interrelated and interdependent. For example, a number of important products offered by the Plastics Department are manufactured wholly or in part by the Ammonia Department.

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THE Plastics Department has plants at Arlington, N. J., Parkersburg, W. Va., and Leominster, Mass. The Ammonia Department operates plants at Belle, W. Va., near Charleston; and at Orange, Tex., and is building a new one at Victoria, Tex.

★ ★ ★

Continental Copper & Steel Buys Madison Wire

CONTINENTAL COPPER & STEEL INDUSTRIES, INC. has acquired the assets of the Madison Wire Company, Inc., Hanover, Pa. The deal provides for Madison's land, building, machinery and equipment.

★ ★ ★

THE property of Madison Wire Co., Inc. adjoins the site of the Hanover Wire Cloth Division of Continental Copper & Steel. This will allow the Hanover Wire Cloth Division to eliminate the purchasing of steel wire which it fabricates into wire cloth of all kinds.

★ ★ ★

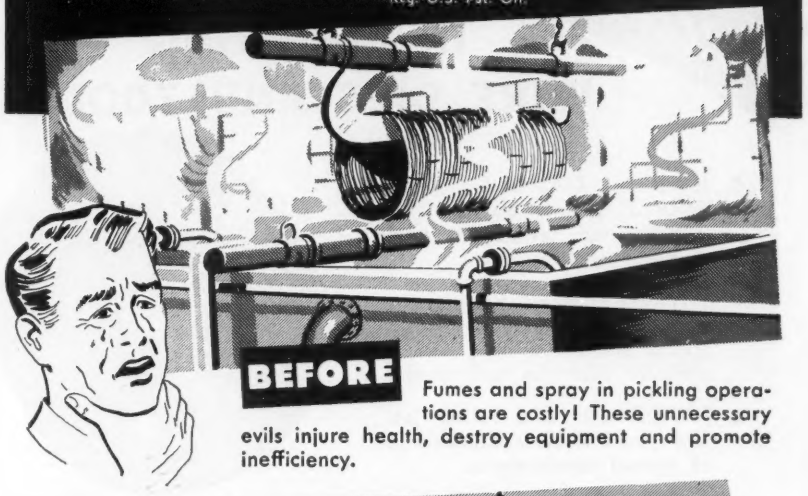
MADISON'S capacity is in the neighborhood of about three and a half million pounds per year which accounts for about 50% of the Hanover Wire Cloth plant's requirements. It is planned to add machinery and equipment to the Madison plant in order to bring its capacity up to the full supply of all Hanover's wire needs.

★ ★ ★

NAME YOUR POISON....

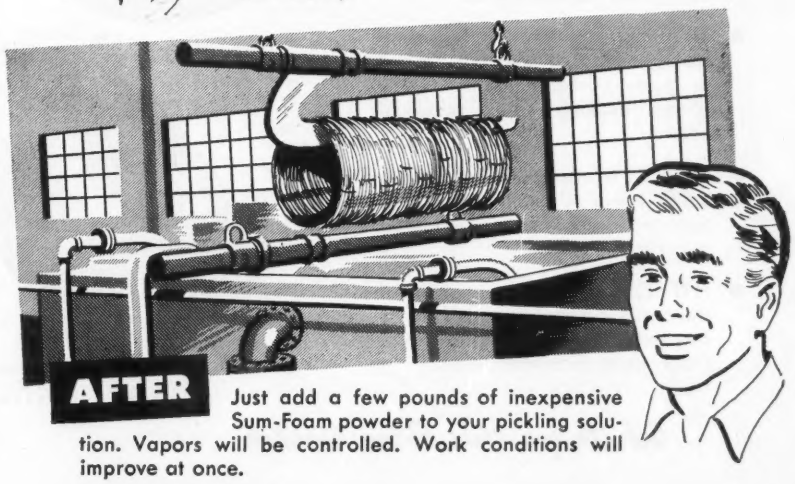
.....is it pickling without Sum-Foam?

Reg. U.S. Pat. Off.



BEFORE

Fumes and spray in pickling operations are costly! These unnecessary evils injure health, destroy equipment and promote inefficiency.



AFTER

Just add a few pounds of inexpensive Sum-Foam powder to your pickling solution. Vapors will be controlled. Work conditions will improve at once.

FREE

50 LB. BAG

LET US PROVE TO YOU WHAT Sum-Foam WILL DO

SHIPPED PREPAID ANYWHERE IN U.S.A.
FOR ANY PICKLING OR ACID CLEANING OPERATION

WRITE! TELEPHONE! WIRE!

(This offer expires in 90 days)

Wm. M. Parkin Company
Highland Building
PITTSBURGH 6, PENNSYLVANIA
MOntrose 0176

PICKLING SPECIALISTS
Parkin of Pittsburgh
IN STEEL SINCE 1860

Only HYPREZ can do a Hyprez Job!

IN FINISHING WIRE DIES AND TOOLS

- HYPREZ DIAMOND COMPOUNDS are formulated of precision-graded, fast-cutting, virgin diamond particles.
- HYPREZ diamond particles are permanently suspended and uniformly distributed in a base of different color for each grade.
- HYPREZ will "stick to the job" and remain stable and uniform at all normal temperatures.
- HYPREZ is packed in dust-proof transparent cartridges (30, 18 and 5 gram content) identified by grade marking and individual color.
- HYPREZ is applied to work from easily operated and waste-saving applicator gun in exactly metered quantities.
- HYPREZ offers 26 engineered standards precisely graded for a complete and perfect job—from rough finish to mirror polish.

A Difficult Die Hyprez Finished To Perfection

Photos courtesy of Eastern Carbide Corporation, New Rochelle, N. Y.

Mandrel Nib Hyprez Finished

Write for this Free Folder

It illustrates proven Hyprez techniques, using simple methods without the use of special equipment. They demonstrate the speed, efficiency, and economy of using Hyprez.

For this folder or for a free demonstration write to Dept. W-1049.

HYPREZ DIAMOND COMPOUNDS

AN EXCLUSIVE PRODUCT OF

HYPREZ DIVISION

ENGIS EQUIPMENT CO., 431 S. DEARBORN ST. CHICAGO

A.S.&W. Establishes Scholarships

AMERICAN STEEL & WIRE CO. has established two full time day school scholarships for employees and their sons at the College of Engineering and Science, Case Institute of Technology, in Cleveland, beginning with the academic year 1949-50.

★ ★ ★

THE scholarships will cover full tuition for a complete four-year college course, provided that high academic and personal standards are maintained and the students receive the recommendations of the Case Scholarship Committee.

★ ★ ★

EMPLOYEES of any of the Works or Offices of American Steel & Wire Co. and their sons are eligible to apply for one of these scholarships. The applicants must be graduated from an accredited high school and must be able to meet the requirements for admission to the College of Engineering and Science of Case Institute of Technology.

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Polyethylene in Submarine Cables

POLYETHYLENE, used widely in several phases of the wire and cable industry has now been demonstrated to be an asset to the manufacture of low voltage submarine cables. A number of actual installations, coupled with laboratory tests, have provided data which promise to promote the use of this plastic in this application.

★ ★ ★

AS in other successful uses of polyethylene, it is the unusual combination of properties available in this material that result in its enthusiastic reception. In most wire and cable applications, the superior electrical properties have been widely utilized. Its chemical stability, lightweight, inherent flexibility, and ease of fabrication have all added to its overall usefulness. These properties combined with polyethylene's extremely low rate of water absorption have con-

tributed to its successful use in submarine cable.

★ ★ ★

THREE outstanding examples of these submarine cables are described in report, No. 36, issued by **The Bakelite Corporation,** 30 East 42nd St., New York 17, N. Y.

★ ★ ★

Notice of Revision in Program

of Symposium on the Use and Care of Diamond Wire Drawing Dies

Note: This revision was received too late to be altered in the program printed elsewhere in this issue.

Chairman: A. D. Leveridge, Executive Manager, Industrial Diamond Ass'n of America.

1. **Use and Care of Diamond Wire Drawing Dies—John W. Cowan, Chairman, Diemakers Committee, I.D.A.**
2. **Symposium (Question and Answer Period——William Hard, Moderator.**
   Participants:
   John W. Cowan, Wayne Wire Die Co., Hillside, N. J.
   Russell E. Connor, Detroit Wire Die Co., Fort Wayne, Ind.
   Fernand Durand, Cochaud Wire Die Co., New York, N. Y.
   Otis Ferrier, Indiana Wire Die Co., Fort Wayne, Ind.
   Charles J. Royle, Hudson Wire Co., Ossining, N. Y.
   George Stewart, Sylvania Electric Co., Newark, N. J.
   William Wind, Wilbur B. Driver Co., Newark, N. J.
   Representative, Ajax Industrial Supplies, Fort Wayne, Ind.

★ ★ ★

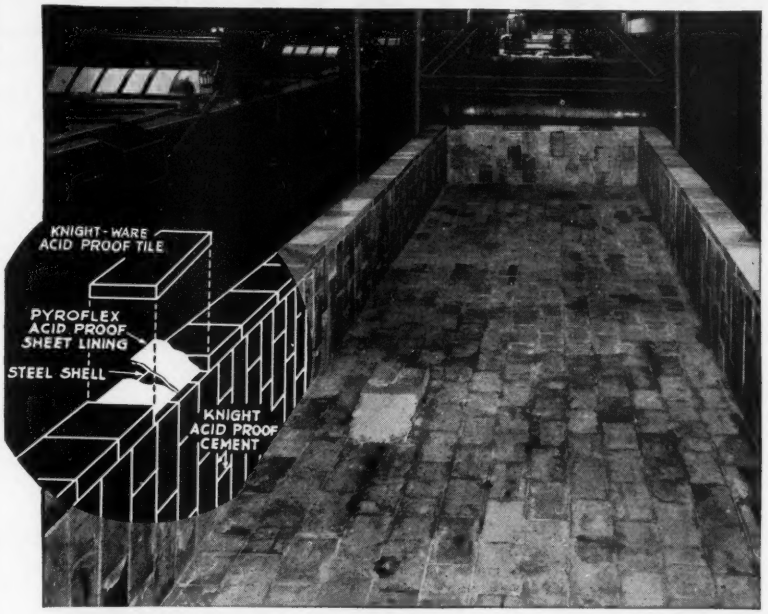
The program includes projections of die channel profiles and micro-photographs or drawings of wire drawn through the dies described.

★ ★ ★

Youngstown Sheet and Tube Honors Blast Furnace Department for Safety Record

SOMETHING new has been added to the blast furnace department of **The Youngstown Sheet and Tube Company** at Campbell.

★ ★ ★



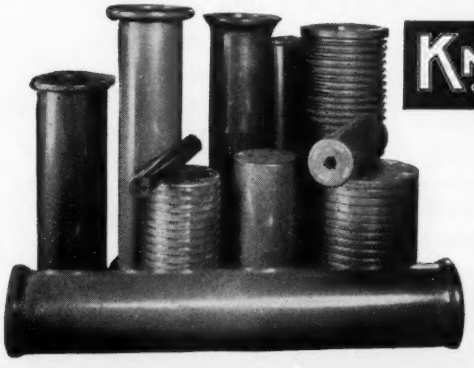
PYROFLEX-Constructed Pickling Tank in Continuous Strip Steel Line.

Corrosion-Proof Rolls and Processing Tanks

Knight-Ware corrosion-proof wire and sheet rolls or sinkers are made to meet customers' needs. You can choose the diameter, groove spacing and length to fit your operation. They are entirely acid-proof and hard with no coating or shell to depend on for acid resistance or wear.

Pickling and plating tanks which are acid-, alkali- and leak-proof are available of Pyroflex Construction. These are steel tanks lined with suitable corrosion-proof materials to best meet your particular operating conditions.

Knight engineers welcome your inquiries on wire rolls and Pyroflex processing tanks. Be sure to give them as complete data as possible regarding the character and purpose for which this equipment is to be used.

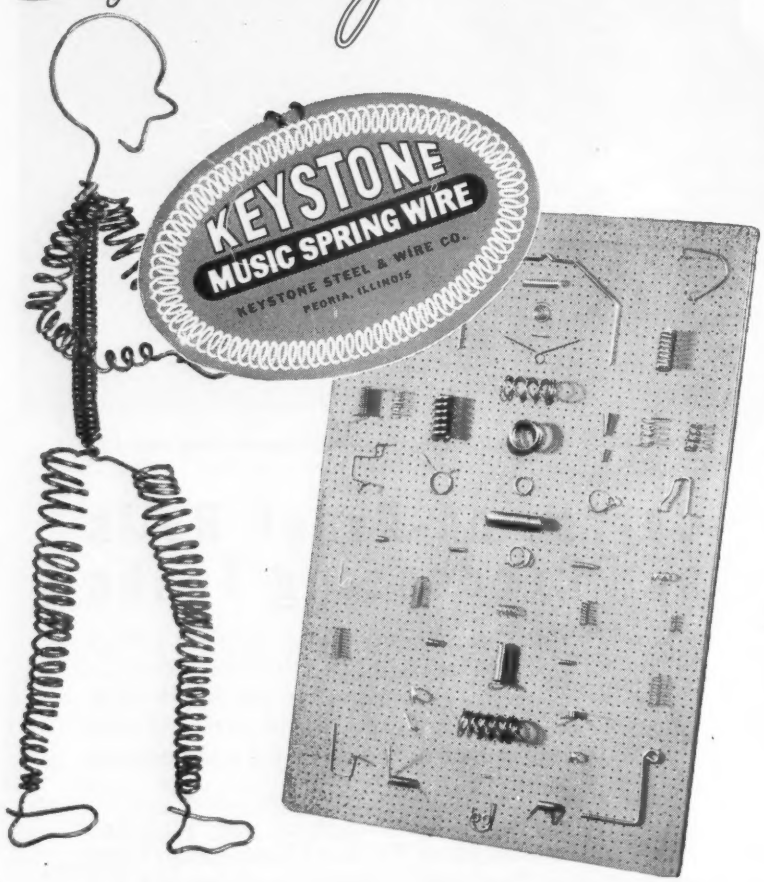


KNIGHT-WARE CHEMICAL EQUIPMENT

MAURICE A. KNIGHT
44 Kelly Ave., Akron 9, Ohio

Knight-Ware Wire and Sheet Rolls or Sinkers Are Made to Fit Your Operations.

MUSIC
Spring Wire



An ultra-quality wire used to manufacture intricate springs and parts where top product performance is desired.

Rigid control of chemical composition and processing methods assure its uniformity and structural soundness. Our specialized coiling, twist and bend tests are added safeguards of dependability.

KEYSTONE
MUSIC SPRING WIRE
KEYSTONE STEEL & WIRE CO.
PEORIA, ILLINOIS

SPECIAL ANALYSIS WIRE
for all industrial purposes

KEYSTONE STEEL & WIRE COMPANY
PEORIA 7, ILLINOIS

IT is a bronze plaque, presented to the department by **H. E. Engelbaugh,** manager of the company's Youngstown district properties, for completing 1,000,000 man hours without a disabling injury.

★ ★ ★

THIS is the third million man-hour plaque presented to this department—the only department in the company's Youngstown district to achieve such a record. It won its first plaque in 1935 and its second plaque 10 years later.

★ ★ ★

MR. ENGELBAUGH said the three records have been chalked up in face of the fact that blast furnace work is considered as hazardous as any steel plant operation. He attributed the records to cooperation of employees and supervision on all general company safety problems and in closely following safe practices for blast furnaces.

★ ★ ★

W. H. YECKLEY, general superintendent of the Campbell Works Steel Plant, Blast Furnaces and Struthers Works, said employees had to perform like a well organized team to win the award.

★ ★ ★

D. P. CROMWELL, superintendent of blast furnaces, said he felt that it was the spirit of watching out for the other fellow that exists between men and their supervisors which made this award possible.

★ ★ ★

INCLUDED in blast furnace operation is the sintering plant which went into operation in October, 1942. At the start of sintering operations, Raymond McGee, general foreman, was the only man with any sintering plant experience. Every member of his crew, including his turn foreman, had to be trained in making sinter. This new operation provided increased hazards for the blast furnace department.

★ ★ ★

Outstanding Personalities of the Wire Industry

Rylander, President, Canadian Permag Products, Ltd.

ALLAN A. RYLANDER has been elected President of **Canadian Permag Products, Ltd.** This announcement is made by Edward Magnuson, founder, who is now Chairman of the Board.

★ ★ ★

CANADIAN Permag Products, Ltd. manufactures, sells and service Permag Industrial Cleaning Compounds in Canada.

★ ★ ★

AFTER five years with a private bank on Wall Street, Mr. Rylander joined Magnuson Products Corporation in Brooklyn in 1929. He went to Montreal in 1933 as Assistant Manager of Canadian Permag. In 1937, he became Assistant Treasurer and Manager, and in 1943 he became Treasurer. He was elected Director in 1944 and made General Manager in 1946. Mr. Rylander is also a Director of Magnuson Products Corporation in Brooklyn. Besides his business activity, he is active in many trade, social and athletic organizations.

Allan A. Rylander, President Canadian Permag Products, Ltd., Montreal, Canada.

★ ★ ★

Dahl and Worthington Advanced to New Posts in Columbia Steel

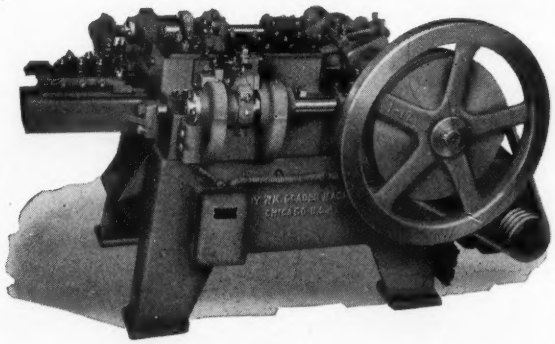
LAURENCE S. DAHL has been elected vice president in charge of operations, **Columbia Steel Co.**, San Francisco. Mr. Dahl comes to Columbia from Carnegie-Illinois Steel Corp., where he had been general superintendent of that company's operations in the Youngstown district since 1947.

★ ★ ★

H. S. WORTHINGTON has been made assistant to the vice president in charge of operations. Mr. Worthington started with American Steel & Wire Co. in 1915 and in 1933 transferred to Columbia, where he has held several executive positions.

★ ★ ★

GLADER HIGH SPEED WIRE NAIL MACHINE



MACHINE ARRANGED FOR INDIVIDUAL MOTOR DRIVE

High tonnage output, and low maintenance costs, have resulted in Glader Machines being accepted as standard equipment in every large nail mill built in the United States in the past twenty years.

Glader Machines are operating in most of the wire producing mills throughout the world.

These machines are made in eleven different types and sizes. This enables us to cover the range of sizes of nails produced with the greatest efficiency.

For further information please address,

WM. GLADER MACHINE WORKS
210 No. Racine Ave.
Chicago 7, Illinois
Export Dept.: 122 E. 42nd Street, New York 17, N. Y.

Apex Alkali Products Announces Two Appointments

WILLIAM B. BAUZENBERGER, who has been with the company for eight years, has been made Sales Manager. While he will serve Western Pennsylvania, West Virginia and Ohio, with headquarters at 114 Youngwood Drive, Mt. Lebanon, Pa., he will be available for any territory. His long familiarity with wire drawing practices have made him well-known in wire circles.

William B. Bauzenberger, Sales Manager, Apex Alkali Products Company, Philadelphia, Pa. *

★ ★ ★

JOHN H. ULRICH, a graduate chemical engineer, who was trained in the army for Chemical Warfare, has also joined Apex to represent them in Eastern Pennsylvania, Delaware and Maryland. He will have headquarters at Mountain Road, Pennwyn, Reading, Pa.

★ ★ ★

BEFORE coming to Apex, Mr. Ulrich worked first for DuPont at Wilmington in their experimental station and later for the American Aniline Products, Inc., Lock Haven, Pa.

★ ★ ★

BOTH the Company and the Messrs. Bauzenberger and Ulrich are to be congratulated on these fine appointments.

★ ★ ★

John H. Ulrich, Chemical Engineer, Apex Alkali Products Company, Philadelphia, Pa. * *

Phone 2-3043

HOWSAM SPOOL COMPANY

500 RATHBONE AVE AURORA ILLINOIS

Firth Sterling Names New Sales Manager, Carbide Sales, and Other Appointments

C. R. HARMON has been appointed Sales Manager, Carbide Sales Division, Firth Sterling Steel & Carbide Corporation.

★ ★ ★

MR. HARMON has been District Sales Manager of Firth Sterling's Pittsburgh District since March, 1947. Formerly Manager of Carbide and Specialty Sales for Jessop Steel Company, he later organized and acted as Sales Manager for Penn Carbide and Alloy Casting Company before joining Firth Sterling.

★ ★ ★

J. M. STOKES was appointed Assistant Sales Manager, Carbide Sales Division. Mr. Stokes has been associated with the Carbide Industry since its infancy, and was located at Firth Sterling's Detroit Sales Office for 18 years before transferring to McKeesport, Pa., three years ago.

★ ★ ★

J. J. SOWKO has been appointed Pittsburgh Branch Sales Manager. He has been associated with Firth Sterling for ten years. Prior to this promotion, he was Manager of Carbide Sales for the Company in the Chicago District.

★ ★ ★

C. R. Harmon, Sales Manager Carbide Sales, Firth Sterling Steel & Carbide Corporation, McKeesport, Pa.

Crucible Steel Appointments

ISAAC M. CHAMBERS, assistant general superintendent of the Spring Works, **Crucible Steel Co. of America,** Pittsburgh, Pa., has succeeded **M. V. O'Donnell** as general superintendent. Mr. O'Donnell has retired after 40 years of association with the company.

★ ★ ★

C. F. & I. Appointments

ALFRED E. GIBLIN has been named assistant plant manager of the Wickwire Spencer Steel Div., **Colorado Fuel & Iron Corp.,** at Buffalo, succeeding **Graham W. Wickizer,** who has returned to the company's Pueblo plant. Mr. Giblin had formerly served as mason-labor department superintendent. **J. Wilbur Campbell** has been made superintendent in charge of wire operations at the Buffalo works, succeeding **A. J. LaBlanc,** who resigned. Mr. Campbell had been assistant superintendent of the wire mill.

★ ★ ★

G. E. Appointments

LLOYD C. SHACKELFORD has been appointed wire and cable specialist for the construction materials department of **General Electric Co.**, Bridgeport. He has his headquarters in Seattle. Mr. Shackelford joined G.E. in 1941. **Harold W. Parrott** has been appointed operating manager of the new southeastern district warehouse of the department, with headquarters in Charlotte, N. C. Mr. Parrott has been associated with General Electric since 1930.

★ ★ ★

Western Electric Appointments

THE WESTERN ELECTRIC COMPANY has announced the appointment of **Clyde C. Randolph** as acting works manager of the company's Point Breeze Works in Baltimore and as works manager of the Tonawanda Plant in Buffalo, New York, and the Allentown Plant in Allentown, Pa.

★ ★ ★

RANDOLPH, who has been manager of the company's Radio Shops in Winston-Salem, N. C., succeeds **Arthur B. Goetze** who was transferred to the Chesapeake and Potomac Telephone Company, where he has been elected Vice-President in charge of personnel.

★ ★ ★

F. E. HENDERSON, until now superintendent of the Cable Shops at Point Breeze, was named manager of the Radio Shops, succeeding Randolph whose appointment to the Point Breeze post follows a 23-year career with Western Electric in its manufacturing and radio divisions.

★ ★ ★

Pittsburgh Screw & Bolt Makes Changes

J. M. YAHRES, executive vice president of the Pittsburgh Screw & Bolt Corporation, announced that **Wallace W. Smith,** formerly general superintendent of the Pittsburgh plant, has been appointed manager of operations of both the Pittsburgh and Graham plants.

★ ★ ★

RUSSELL T. POLLOCK, formerly assistant superintendent of the Pittsburgh plant, has been appointed general superintendent of the Pittsburgh plant.

★ ★ ★

R. L. IRVIN, works manager of the Graham Bolt and Nut Division, will continue in his present capacity.

★ ★ ★

F. B. GORDON, formerly vice president in charge of operations, and **G. H. Lee** will continue as vice presidents of the corporation in advisory positions.

★ ★ ★

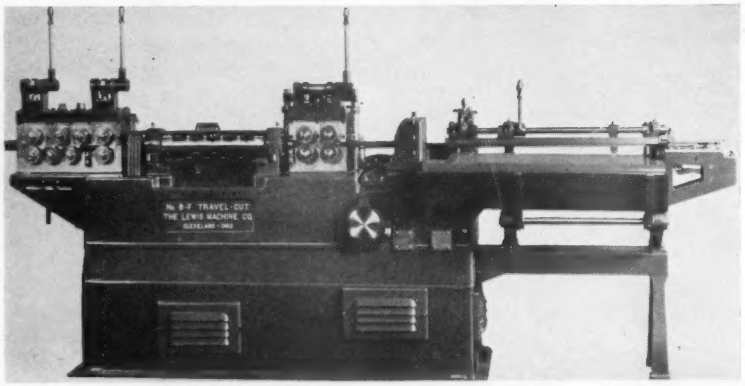
Stukel Joins Youngstown Sheet and Tube

JOHN E. STUKEL, JR., former assistant professor at Carnegie Institute of Technology, Pittsburgh, has joined the operating department of **The Youngstown Sheet and Tube Company** as a development engineer, working under Dr. **Karl L. Fetters,** special metallurgical engineer, in Youngstown.

★ ★ ★

CUT YOUR CUTTING COST WITH

LEWIS TRAVEL-CUT



Wire Straightening & Cutting Machines

The simplicity of design and rigid construction of the Lewis Travel-Cut makes it well suited for the most severe high-production requirements. This machine feeds the wire from the coil, straightens, gauges to accurate length, and cuts while in motion thus producing uniform diameter rod free of arbor swell and feed roll marks. It is particularly adapted to precision work on bright finished steel, brass, aluminum, stainless, and alloy wire. This method of cutting is also very efficient for short lengths such as welding rod, special bolts, etc., and increases the over-all efficiency approximately 20% over the conventional type of cut-off.

Machines built in various sizes to handle from 1/16" up to 3/4" diameter, and 1/16" to 5/8" square or equivalent area in hexagon and flat.

Exclusive Representatives

EAST: Penn Machinery Company, 117 North Third Street, Philadelphia 6, Pennsylvania.

MIDDLE WEST: Steel & Wire Machinery Company, 1017 Helmsdale Road, Cleveland 12, Ohio.

CENTRAL: Moslo Machinery Company, 2443 Prospect Avenue, Cleveland 15, Ohio.

CANADIAN: Empire Engineering Company, 11 Wellington Street East, Toronto 1, Ontario.

CONTINENTAL EUROPE: Gaston E. Marbaix, Ltd., Devonshire House, Vicarage Crescent, London S.W. 11, England.

Also agents in Paris, Stockholm, Rotterdam, Brussels, Zurich, Milan, Bombay and Melbourne.

The LEWIS MACHINE Co.
3441 E. 76th STREET
CLEVELAND, OHIO

Old Company Reorganizes and Expands

THE ELECTRO - CHEMICAL SUPPLY AND ENGINEERING CO. of Emmaus, Penna. one of the oldest firms in the acid and corrosion proofing field, announces a complete reorganization. The new officers and key men aggregate approximately a century of experience in this highly technical and specialized work. A new plant with 16,000 square feet of floor space is fully equipped at Emmaus, (Allentown), Penna., and went into operation on the first day of July.

★ ★ ★

THE officers of the company are: **Dr. C. R. Payne,** President; **J. Wm. Grant,** Vice President and Sales Manager; **Wm. A. Sesher,** Treasurer and Production Manager; **Walter L. Sheppard, Jr.** is Advertising Manager and Export Sales Manager.

★ ★ ★

THE Electro-Chemical Supply and Engineering Co. was founded in 1912, and was one of the first Companies in the United States to manufacture acid-proof cements and to engineer acid-proof construction. It was the first company in the United States to manufacture a two-part fast setting silicate cement (Duro), and was the first to manufacture and install Thiokol plasticized sulphur cement —then called Thiogrout and now known as Brimsto.

★ ★ ★

John C. Blake Appointed General Manager Phosphor Bronze Corp.

JOHN C. BLAKE has been appointed general manager, **Phosphor Bronze Corp.,** operation of which has been moved from Philadelphia to Seymour, Conn. He resigned as general sales manager of Riverside Metal Co., Riverside, N. J., in June after 24 years of association with that company, serving in various executive assignments. Mr. Blake started his career in the brass mill industry as a clerk in the wire mill of Seymour Mfg. Co., Seymour, Conn., in 1915.

★ ★ ★

Reeves Pulley Appoints New Works Manager

JOHN S. MICHIE, formerly of the **Diebold, Inc.** of Canton, Ohio, has been appointed Works Manager of Reeves Pulley Company, manufacturers of variable speed control equipment. The appointment was made in connection with an expansion program of the plant.

★ ★ ★

HE will be in charge of all plant manufacturing production planning, time standards and methods.

★ ★ ★

MR. Michie is a graduate of the University of Edinburgh in Scotland and has been engaged in various factory management positions in Canada and the United States since 1924.

★ ★ ★

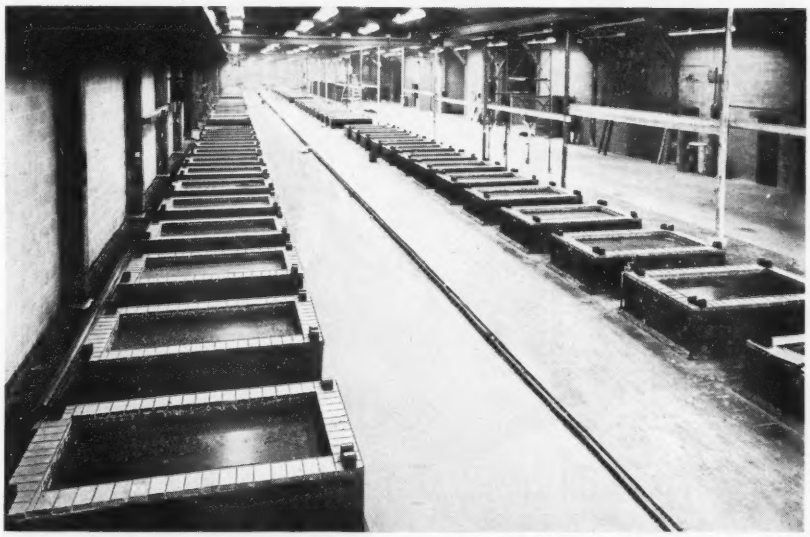
HE succeeds H. E. Brooks, who retired recently after 29 years of service with the Company.

★ ★ ★

CORROSION DAMAGE IS COSTLY...

not only in repair costs, but also

IN TIME LOST TO PRODUCTION!



Concrete Tanks lined with ATLASTISEAL MEMBRANE *and* ACID BRICK *joined with KOREZ (R) chemical cement.*

ATLAS chemical construction materials, ATLAS design and ATLAS field supervision will reduce your maintenance costs to an absolute minimum.

For new construction specify these ATLAS materials — TEGUL-VITROBOND (R), KOREZ (R), CARBO-KOREZ (R), ALKOR, VITREX, REWBON, NEOBON, ZEROK, ATLASTISEAL.

THE ATLAS MINERAL PRODUCTS COMPANY

MERTZTOWN, PENNA. HOUSTON, TEXAS

C. J. Tagliabue Appoints New Sales Representatives

C. J. TAGLIABUE CORPORATION, wholly-owned subsidiary of the Weston Electrical Instrument Corporation, has announced the appointment of the following district sales representatives:

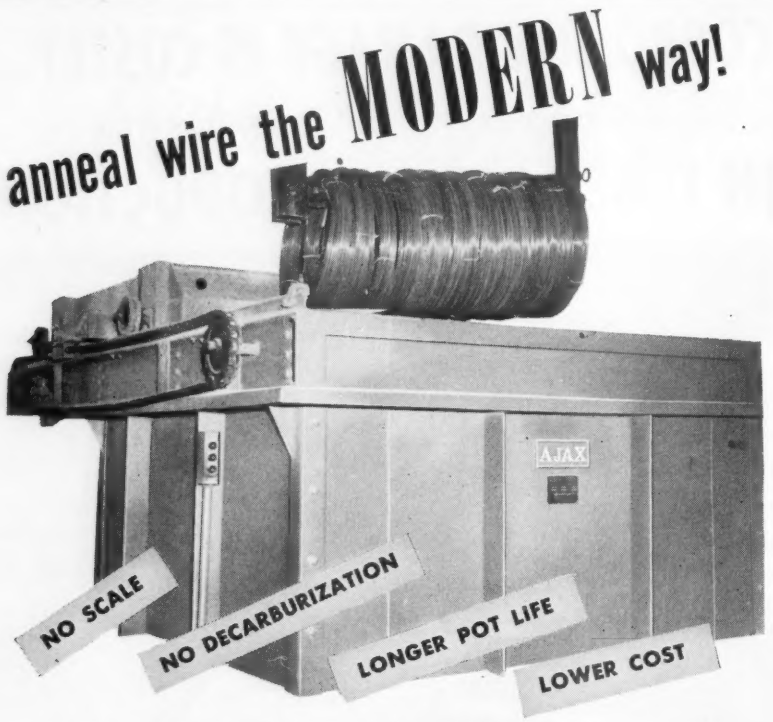
★ ★ ★

E. A. THORNWELL, INC., Atlanta; Ranson, Wallace & Company, Charlotte; Ambos-Jones Company, Cleveland; Butler and Land, Dallas; Lynn Elliott Company, Houston; Curtis H. Stout, Little Rock; Geeseka and Pinkney, Minneapolis; Joralemon, Craig & Company, Philadelphia; J. E. Redmond Supply Co., Phoenix; and Riddle and Hubbell, Tulsa.

★ ★ ★

THE complete line of Tagliabue instruments includes automatic controllers, hydrometers, hygrometers, moisture meters, oil testing instruments, pyrometers, recorders, recorder controllers, resistance thermometers, thermometers (all types), vacuum gauges and valves.

★ ★ ★



You'll save money, you'll improve efficiency along many lines with the unique Ajax Electric Salt Bath wire annealing method. It requires less floor space, less labor, less maintenance. Heating cycles average less than 20 minutes, even on difficult jobs. There is no scaling, no decarburization, no explosion hazard, none of the bothersome problems entailed with atmosphere equipment. Salt bath treating does the work faster, better, cheaper!

Ideal for annealing low- or high-carbon and stainless steel wire and rod; annealing aluminum, and copper and silver alloys; and for descaling stainless and alloy steel wire in molten salt baths.

AJAX ELECTRIC COMPANY, INC.
Frankford and Delaware Aves. · Phila. 23, Pa.
The World's Largest Manufacturer of Electric Heat Treating Furnaces Exclusively

WRITE FOR YOUR COPY!
This 72-page Ajax booklet tells the entire story of salt bath heat treatment as applied throughout modern industry. Ask for Booklet 116.

AJAX HUTTGREN **ELECTRIC SALT BATH FURNACE**

M. J. Donachie Elected Beryllium Corp. Director

OTTO T. ENGLEHART, president of the **Beryllium Corporation,** announces the election of **Matthew J. Donachie** to the board of directors. Mr. Donachie is vice president and works manager and has been associated with the company in various consulting capacities since 1935.

★ ★ ★

SINCE coming to this country from Scotland in 1926 Mr. Donachie has been associated with several leading firms in the United States as a consulting metallurgist. He is an alumnus of the Technical College, Coatbridge, Scotland and Franklin Union Institute, Boston, Mass.

★ ★ ★

Atlas Steels, Ltd. Appointments

ATLAS STEELS LTD., Welland, Canada, announces appointment of **Gilbert Soler,** formerly works manager, as vice president-manufacturing operations and as a director. **E. P. Geary, D. W. Lathrop** and **F. L. Whitaker** have also been added to the company's board of directors.

★ ★ ★

Edward J. Burnell

Edward J. Burnell, vice-president and general sales manager, and director, of Link-Belt Company, died at his home in Winnetka, Ill., on July 22, after an illness of several months.

Mr. Burnell served Link-Belt Company in many important capacities, in engineering, sales and plant management. He was a director of the American Mining Congress, Drexel State Bank of Chicago, Foundry Equipment Manufacturers Association and the Conveyor Equipment Manufacturers Association.

★ ★ ★

R. H. Marshall Appointment

RICHARD H. MARSHALL, formerly production metallurgist of **Timken Roller Bearing Co.,** has joined the metallurgical staff of **Climax Molybdenum Co.,** Chicago.

★ ★ ★

A Review of Recent Wire Patents

NO. 2,477,690, APPARATUS FOR FORMING TWISTED WIRE STRUCTURES, patented August 2, 1949 by Frederick A. French, Trenton, N. J., assignor to John A. Roebling's Sons Company, Trenton, N. J., a corporation of New Jersey.

Electrical means control the amount and direction of twist imparted to individual wires or filaments in wire cable forming machines.

★ ★ ★

NO. 2,477,808, ELECTROLYTIC APPARATUS FOR TREATMENT OF MOVING STRIP, patented August 2, 1949 by Carl G. Jones, Youngstown, Ohio.

Associated with a number of curved electrodes, disposed along the path of travel of the strip, is an apertured pipe so that electrolyte under pressure may be ejected from the apertures selectively in accordance with the positioning of the several curved electrodes and their supporting collars relatively to the pipe.

★ ★ ★

NO. 2,477,841, METHOD OF COATING METAL SURFACES, patented August 2, 1949 by Herbert K. Ward, Birmingham, Mich., assignor to Parker Rust Proof Company, Detroit, Mich., a corporation of Michigan.

A method of coating metal surfaces containing iron and aluminum and which can be coated by phosphate and fluoride solutions is disclosed, which comprises subjecting the surfaces to the action of a hot aqueous solution containing as its essential ingredients dihydrogen phosphate, an oxidizing agent, fluoborate, an excess boric acid, and replenishing the fluoborate and boric acid content of the solution by the addition of a single fluoride and only the amount of boric acid to keep the excess boric acid in the solution within the desired working range.

★ ★ ★

NO. 2,478,397, WIRE FEED MECHANISM, patented August 9, 1949 by Roy G. Hoffert, Racine, Wis., assignor to Acme Steel Company, Chicago, Ill., a corporation of Illinois.

More specifically, the invention resides in the provision of a wire check adapted to be used with a wire feeding mechanism as a preassembled unit.

★ ★ ★

NO. 2,478,716, MACHINE FOR WINDING FLAT OBLONG COILS, patented August 9, 1949 by Willard C. Shaw, Anderson, Ind., assignor to General Motors Corporation, Detroit, Mich., a corporation of Delaware.

A machine is provided for winding a flat, oblong coil of wire and includes a winding form having a plane surface and an oblong boss extending therefrom toward which the wire is urged in winding.

Complete Description and Drawings of Patents May Be Had for 50 cents, outside the United States and Canada $1.00. Address, Wire & Wire Products, 300 Main St., Stamford, Conn.

NO. 2,479,400, METHOD OF FORMING COIL ASSEMBLIES, patented August 16, 1949 by Valentine W. Pecoroni, Bridgeport, Conn., and Richard B. Gethmann, Fayetteville, N. Y., assignors to General Electric Company, a corporation of New York.

The method comprises winding an electrical coil having a number of layers of conductors, interleaving these layers with strips of a thermoplastic material, allowing a margin of the strips to extend longitudinally beyond the layers of the conductors, placing the coil in a mold, injecting molten thermoplastic material into the mold to cause the molten thermoplastic material to surround the assembly, and allowing the assembly to cool, whereby the molten plastic material solidifies and fuses with the plastic strips hermetically sealing the assembly.

★ ★ ★

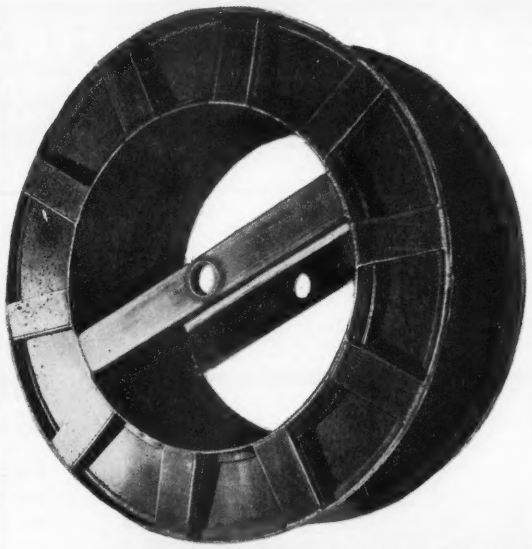
NO. 2,479,730, SCREW, patented August 23, 1949 by Harcey L. Dewar, Hollywood, Calif., assignor to Lockheed Aircraft Corporation, Burbank, Calif.

This screw is of the self-drilling and self-tapping type. There is one claim.

★ ★ ★

NO. 2,479,919, METHOD OF COVERING A WIRE HAVING INTERSTICES THEREIN, patented August 23, 1949 by James E. Flood, Norwich, Conn., assignor to The Plastic Wire &

CONCORD



REELS and SPOOLS

DESIGNERS AND FABRICATORS OF ALL TYPES OF METAL REELS AND SPOOLS. APPROVED AND USED BY THE LARGEST WIRE PRODUCERS.

CONCORD PRODUCTS CORP.

3269 NORTH CALIFORNIA AVE.

CHICAGO 18 ● ILLINOIS

The SPECIALISTS in Wire-Straightening and Wire-Cutting!

Diameter Range — 1/16" to .005"

PRECISION - Our Motto

DON'T hesitate to call on us when you are confronted with wire-straightening problems involving close tolerances and absolute accuracy. For seventeen years we have specialized in straightening and cutting all gauges of fine wire, hard or soft, ranging in diameter from one-sixteenth of an inch down to five-thousandths of an inch. We employ gun-barrel accuracy in straightening lengths from one inch to ten feet or any fractional part thereof. Ends cut absolutely clean without burrs.

●

ASK ABOUT OUR UNEXCELLED FACILITIES FOR CLEANING AND POINTING WIRE ALREADY STRAIGHTENED AND CUT.

ALL TYPES OF WIRE...

- Nickel
- Stainless Steel
- Bronze
- Brass
- Copper
- Alloy Wire
- Music Wire
- Tag Wire
- Florist Wire

Write us today!

Manufacturers of the famous ARMA PAPER CLIP

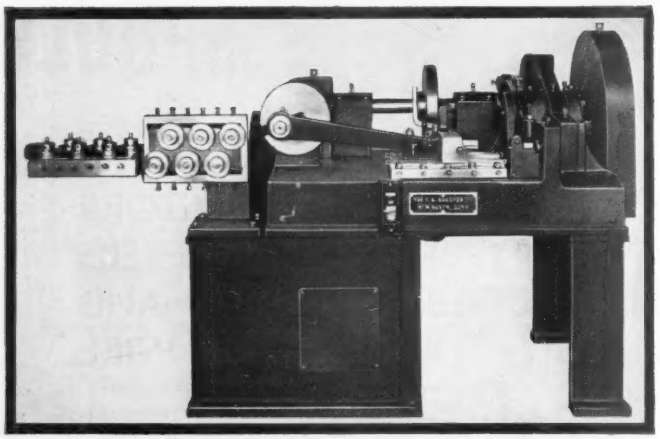
PITTSBURGH CUT WIRE COMPANY

1112-20 GALVESTON AVENUE · PITTSBURGH, PENNSYLVANIA.

TELEPHONE: CEdar 4702

SHUSTER AUTOMATIC SLIDE FEED MACHINES

Straighten and Cut Round or Shaped Stock — Short Lengths



Production, 125 pieces per minute

HIGH PRODUCTION HIGH PRECISION

Recommended wherever accuracy and a perfectly square cut are a "must." In this machine, the stock receives a shearing cut from two round dies. This method of cutting produces an accurately square cut and holds the length of cut to very close tolerances.

Capacity: 1/2" to 10" lengths; maximum diameter of rod, 9/16"; production, 125 pieces per minute. May be had without the 12-roll straightener if your stock is already straightened.

Detailed circulars on request. When writing please describe your set-up.

Mfd. by METTLER MACHINE TOOL, INC., 132 W. Lawrence St., New Haven, Conn.

SHUSTER *Automatic* — *Since 1866*

WIRE STRAIGHTENING AND CUTTING MACHINES

Cable Corporation, Norwich, Conn., a corporation of Connecticut.

Coating, comprising an unheated fluid coating composition of thermoplastic resinous synthetic polymer, is caused to enter the interstices and interlock therewith, whereupon there is extruded a plastic jacket of cover material of the same thermoplastic resinous synthetic polymer in hot plastic form over the coating, the cover material and coating becoming an integral cover mechanically secured to the wire.

★ ★ ★

NO. 2,479,924, METHOD OF MAKING ELECTRICAL CONDUCTOR CABLES, patented August 23, 1949 by Randall Gillis, Westfield, N. J., assignor to Western Electric Company, Incorporated, New York, N. Y., a corporation of New York.

The conductor is of the central conductor (wire) with metal tape sheath class, with the two edges of the tape forming a seam running longitudinally along the core.

★ ★ ★

NO. 2,480,005, WIRE ROPE, patented August 23, 1949 by Andrew Travers Ewell, Atlanta, Ga., assignor to Don P. Gavan, Atlanta, Ga.

This wire rope comprises a number (as seven) of metal strands surrounding a core of elastic material, each of the strands being composed of a number of wires twisted about a hemp core containing an absorbed lubricant.

★ ★ ★

NO. 2,480,138, WIRE FEEDING MECHANISM, patented August 30, 1949 by Herman A. Imhof, Beverly, Mass., assignor to United Shoe Machinery Corporation, Flemington, N. J., a corporation of New Jersey.

The mechanism is adapted for use in shoe making machinery.

★ ★ ★

NO. 2,480,158, SPRING AND SPRING CONSTRUCTION, patented August 30, 1949 by David T. Owen, Cleveland Heights, Ohio.

An upholstered spring construction is provided comprising a number of springs each embodying a main body portion and an auxiliary, spirally wound top portion integrally extended from one end of the main body portion, means to couple the main body portions of the springs to form a wire spring construction having a unitary main spring body and a number of spirally wound, individual auxiliary springs integrally extended from the main spring body.

★ ★ ★

NO. 2,480,677, GRID MAKING MACHINE, patented August 30, 1949 by Wilbur L. Sheffield, Auburndale, Mass., assignor to Raytheon Manufacturing Company, Newton, Mass., a corporation of Delaware.

This machine is adapted to wind and secure a winding wire around an elongated side rod wire.

★ ★ ★

New Apex Product Suppresses Foaming

A NEW product of particular interest to wire drawing men has been announced by **Apex Alkali Products Company** of Philadelphia, Pa. It is called FOAMTROL*.

★ ★ ★

IT is a nearly colorless, oily liquid of light viscosity, which when added to drawing, cutting, cleaning or similar solutions, suppresses or prevents foaming in all types of aqueous and non-aqueous systems. It is lighter than water and insoluble in the water phase of emulsions. It is said that no contamination of the emulsions takes place.

★ ★ ★

FOR full details please write or telephone the company.

★ ★ ★

* **Pat. applied for.**

Proven by wide usage—greater efficiency in **Serving and Braiding** *when packages of* **Silk-Nylon-Acetate** *are the product of our Mills.*

Producers also of **Tracer and Marker Trams** *which meet the* **Underwriters' Laboratory** *specifications.*

Consult us on your specific problems.

Belding Corticelli

"Well Over a Century of Leadership"

Industrial Yarn Division **119 West 40th St., New York 18, N. Y.**

Use of G-E ACA Motor as Drive For Wire-Drawing Equipment Helps Increase Production of Solder Wire

USE of a General Electric 15-hp variable-speed ACA motor as a drive for a new wire-drawing process has enabled the American Smelting and Refining Corp. to increase its production of high-quality solder wire with a minimum of expensive fixtures and dies.

* * *

ENGINEERS of the firm's Federated Metals Division, San Francisco, Calif., pointed out that this motor makes it possible to draw raw solder wire of all grades and diameters varying from 3/16 in. to 1/16 in. on the same drawing rig, simply by changing the motor's speed. Equipped with a remote electrical brush-shifting mechanism, the motor has a 3:1 speed range.

* * *

WORKING as a continuous process through as many as 19 dies, the range of wire diameters presents an almost unlimited combination of speed requirements. The use of this motor and a system of push-button controls enables the operator to set any speed between 150 and 500 feet per minute that the physical properties of the wire solder demand.

* * *

THE motor, of standard squirrel-cage design, is connected to a Pacific Speed Reducer.

* * *

Bulletin on New Lubricant

THE ALPHA CORPORATION, Greenwich, Connecticut, has issued Bulletin No. 52, a four-page folder on **Molykote,** a smooth textured molybdenum-disulfide powder that has unusual lubricating properties.

* * *

IT has been used for wire drawing, deep drawing and as a lubricant additive for greases and oils for assembly and running-in, and for spots that carry unusual bearing loads.

* * *

THEY will be glad to send the Bulletin to interested persons.

* * *

Bulletin on Time Savers for Materials Handling

"TIME SAVERS" is the title of Bulletin 4881, recently published to present the various materials handling equipments which supplement the basic Barrett lines; lift trucks, elevators and storage racks. These supplementary units have, in many plants, yielded important savings in man hours at a low equipment cost.

* * *

PICTURED and described, with prices, in the new bulletin are the Case-Y truck—a lightweight all-welded hand truck developed for the easier handling of cases, kegs and bags; barrel trucks, pick up pallets (for use with hand trucks), chisel trucks, reel trucks, rockeracks (for draining barrels and drums), carboy pourers, steel barrel skids, die tables, stacking

For Improved Drawing and Longer Die Life

Copper-coat WIRE, ROD and TUBING with

Cuprodine®

"Cuprodine", in a simple chemical process without current, deposits an adherent layer of copper on both mild and stainless steels. This layer acts as an effective lubricant—reduces wear and scratching of dies; prolongs die life; minimizes scratching on wire, rod and tubing; and increases the number of draws per die.

CHEMICALS ACP PROCESSES

RUST PROOFING AND PAINT BONDING
Granodine *
Duridine *
Alodine *
Lithoform *
Thermoil-Granodine *

RUST REMOVING AND PREVENTING
Deoxidine *
Peroline *

PICKLING ACID INHIBITORS
Rodine * ®

"Cuprotek"® passivates Cuprodized and other cuprous surfaces, and acts as a paint bond, or a good temporary preventive of corrosion.

Write or call Ambler 0486, for further information on both "Cuprodine" and "Cuprotek".

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PA.
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

frames, bar stock racks, the Nifty lifter and skid system, rectangular and triangular dollies, and Steeleg skids. Representative lift trucks, portable elevators and storage racks are also shown.

★ ★ ★

BULLETIN 4881 will be mailed upon request by **Barrett-Cravens Co.**, 4609 So. Western Blvd., Chicago 9, Ill.

★ ★ ★

Baldwin-Hunter Spring Tester

ARRANGEMENTS for the manufacture and sale of a spring testing machine by the Testing Equipment of **The Baldwin Locomotive Works**, Philadelphia 42, Pa., have been completed with **Hunter Spring Company**, Lansdale, Pa. The instrument was designed for high production inspection and testing of any type of small spring (coil, flat, special design, or spring assembly) within the limits of 12 in. in length and 5 lb. of load. It is especially useful for springs made of wire sizes from 0.005 in. to 0.030 in. in diameter. The equipment is sensitive to load changes of less than 50 milligrams and has a weighing accuracy within ± 0.10 percent.

★ ★ ★

MORE than 50 of these testers are in successful use since they became available last year. Use of this instrument permits closer tolerances in spring specifications, both in their manufacture and utilization. The instrument is expected to eliminate the inaccuracies of improvised special testing jigs and is reported to be much faster than conventional load measuring equipment.

★ ★ ★

New Tie Wire Proves Lighter, Stronger and More Economical

A NEW and lighter tie wire, tested in actual service by neon sign manufacturers in Tulsa, Oklahoma, has proved stronger and lighter than ordinary tie wire. Made of corrosion-resistant Monel the wire is only .015″ in diameter, compared to the .022″ diameter of standard tie wire.

★ ★ ★

MANUFACTURERS who have used the Monel wire for fastening neon glass tubes to signs stress the importance of its corrosion-resistant characteristics as well as its greater strength. Under continued exposure it will not rust nor discolor.

★ ★ ★

METAL GOODS CORPORATION, distributors of the wire, point out that it is easier to work than ordinary tie wire and costs less per foot.

★ ★ ★

FABRICATORS who are interested in learning more about the new wire are invited to write to **Metal Goods Corporation**, 5207 Brown Ave., St. Louis, Missouri.

★ ★ ★

Martin Technical Service Described

WHY more and more vinyl resin compounders and processors today are taking advantage of the free technical advisory service made available to clients of **The Glenn L. Martin Company's**

Chemicals Division, Baltimore 3, Md., is explained in an article in a recent issue of THE MARTIN STAR.

★ ★ ★

THE Division's Technical Service facilities are devoted exclusively to the solution of the immediate problems of customers. "Proper exploitation of the new and promising vinyl plastics field," according to the article, "entails a vast and varied program of research calling for close interdependence between the maker and the users of the resin.

★ ★ ★

"ACTUAL performance of the work in the laboratory sometimes involves all three general classes of experimental testing facility—chemical, physical and processing. In addition, the Division's reference library often plays an important role. Finally, the case history of each project—in the form of laboratory notes—is reviewed, and recommendations are drawn up for submission to the client."

★ ★ ★

Booklet Describes Heat Treating and Pickling of Stainless Steels

A NEW 36-page booklet, "Heat Treating and Pickling of Armco Stainless Steels," published by **Armco Steel Corporation,** Middletown, Ohio, presents comprehensive and up-to-date information on heat treating and pickling methods for stainless steels. Recommended procedures, based on practical experience and extensive work in Armco's Research Laboratories, are given in detail so that full advantage can be taken of the valuable properties of stainless steel.

★ ★ ★

SUBJECTS discussed in the booklet are general practices and equipment for heat treating stainless; recommended heat treatments for the chromium-nickel, ferritic chromium, and martensitic chromium (hardenable) types of stainless steel; surface hardening; pickling (scale removal) methods; and heat treating problems and remedies.

★ ★ ★

IMPORTANT NEW material on heat treating the stabilized grades, how heat treatment affects corrosion resistance, and special procedures for heat treating stainless steel forgings are discussed in detail.

★ ★ ★

EXTENSIVE use of charts and graphs to summarize heat treatments and show the effect of variations in heat treating procedure on the mechanical properties of stainless steels make this booklet a handy reference manual for design and processing engineers as well as production departments.

★ ★ ★

New Hydraulically Operated Wire Spooler with Zero to 4,000 FPM Spooling Speed

A HYDRAULICALLY Operated Wire Spooler of revolutionary new design is announced by **Steel Equipment Company,** 2890 East 83rd Street, Cleveland 3, Ohio. The new SECO Spooler features a wide

WILLEY'S SIZING and EXTRUSION DIES

Made of a special grade of tungsten carbide—free from porosity. Great abrasion resistance. Takes high polish. Available in A, blank and rough cored nibs; B, rough cored dies (cased); C, semi-finished, rough drilled dies (cased); D, finished, ready to use.

In making this complicated extrusion die with tungsten carbide insert Willey's used the new, inverted casing method which insures permanent mounting, rigidity and long life. Ideal for cold heading operations. For complete information on this new type casing submit your die problems to Willey's engineers.

WRITE *for* CATALOG

Available to executives and engineers. 64 pages of valuable tool and die information for the man interested in production tooling that cuts costs.

WILLEY'S CARBIDE TOOL CO.
1340 W. VERNOR HIGHWAY,
DETROIT 1, MICH.

speed range, accurate tension and speed control, and a fully adjustable traverse rate.

★ ★ ★

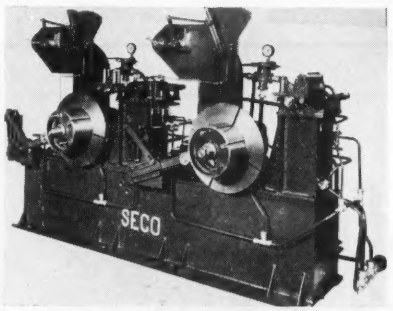
INFINITELY variable speeds between zero and 4,000 FPM are accurately controlled. Efficient traversing with smooth, even coil build-up is possible for wire gauges varying up to 20:1. A pressure control valve adjusts the tension to the desired value for fine or coarse wire. Hydraulic equipment, with a standard AC constant speed motor as a power source, is used, with "finger-tip" controls for accuracy and highest efficiency.

★ ★ ★

A NEW development used in this spooler is a rider-roll control, developed by SECO using Sperry equipment. This control maintains a constant linear spooling speed by automatically decreasing the speed of the spooler as the coil diameter increases.

★ ★ ★

A COMPLETELY satisfactory installation of the new SECO Hydraulically Operated Spooler is being used to handle tinned copper wire direct from the tinning bath. This four-spindle duplex traverse reel handles wire sizes ranging from .100″ thick by .200″ wide to .045″ thick by .500″ wide. Speeds from 150 to 600 FPM are used at fully controlled tension from 75 to 150 pounds. 250 pounds of wire can be coiled on collapsible blocks, 10″ in diameter, 6″ wide with 18″ flanges, or 450 pounds of wire on spools with 14″ diameter cores, 6″ wide, with 24″ flanges.



New Hydraulically Operated Wire Spooler announced by Steel Equipment Company, Cleveland, Ohio.

★ ★ ★

THE new SECO Spooler is engineered to solve current production problems of users and provides built-in flexibility for future requirements. Compact in design, it sets new standards for economical operation, safety and trouble-free maintenance.

★ ★ ★

Send in

Your Order Now

for the

1949 Wire Buyers Guide

DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43, DIE GARD 80, DIE GARD 84, DIE GARD 89, DIE GARD 34, DIE GARD 36, DIE GARD 43,

Die Gard 34

One of a series of compounds for drawing metals, Die Gard 34 is unexcelled for wet drawing of non-ferrous wire in the rod and intermediate size range. We can give you figures showing production results which are pleasing. Wire, Phone, or Write.

OILS of Character

BASIC REFINERS OF FATTY OILS

REILLY-WHITEMAN-WALTON Company

CONSHOHOCKEN, PA.

New Bulletin on Gas-Fired Air Heaters

SURFACE COMBUSTION CORPORATION has released a new bulletin on Gas-Fired Air Heaters and their applications. This is an informative series on industrial heat-treating equipment.

★ ★ ★

IN this bulletin, 'Surface' Air Heaters are described as used by America's largest automobile manufacturers for body paint-drying, as well as other methods of using heated air, such as in the drying and processing of chemicals, ceramic products, paper, foods, textiles, rugs and similar articles.

★ ★ ★

A COPY of this bulletin, No. SC-143, may be obtained by writing to Surface Combustion Corporation, Toledo 1, Ohio.

★ ★ ★

Thermoplastic Cable Sheathing Kraft*

has been adopted over the last decade by an increasing number of

NONMETALLIC SHEATHED CABLE

Manufacturers as their standard serving.

An exclusive product of

Merrimac Paper Co., Inc.

Mills — Lawrence, Mass.

295 Madison Ave., New York City

Also Manufacturers of High Voltage Cable Paper and Armored Cable Kraft.

* Patent applied for.

Tire Bead Wire

TIRES on the family automobile absorb many shocks on the highways. The four tires contain 800 feet of thin steel wire. This "bead" wire is embedded in the tire at the inside diameters. It is at once a foundation and a grip on the rim of car wheels.

★ ★ ★

AN average of about 200 feet of high carbon steel wire is used in the beads of each passenger car tire. In 1948, nearly 67,000,000 such tires were made. That production would require an estimated 2.5 million miles of 0.037 gage bead wire, or 2,358 net tons. In addition, 14,588,000 bus and truck tires were made, each taking about three pounds of bead wire.

★ ★ ★

ONE method of employing bead wire is to form a hoop of the desired circumference out of a single wire. The strand forms a circle 20 to 25 times. The hoop is then wrapped with a material which will bond well with rubber. In the heat of ensuing steps of tire manufacture, bead wire becomes an integral part of the product.

———from Steel Facts

★ ★ ★

Variable Speed Control for Light Horsepower Machinery

A NEW 8-page bulletin describes the improved design of **Reeves** Vari-Speed Jr. unit for light horsepower requirements. Bulletin includes description, photographs, rating and dimension tables, and prices. Unit delivers infinitely variable speed to any driven machine with speed ratios from 1-¾ to 2-¾ : 1, and is made in six sizes for use with any standard constant speed motor up to 1-½ HP. Request bulletin VN-4912 **Reeves Pulley Co.**, Columbus, Ind.

★ ★ ★

The Nylon Coating of Wire

(*Continued from page 934*)

possible to handle the full range of speeds that the requirements indicated at very accurately controlled and constant tension values.

★ ★ ★

BECAUSE of the wide wire size ranges that were to be run on this tubing operation, four fixed speed transmissions were provided in each one of the rotating units. These manual transmissions were electrically interlocked so that it would be impossible for the operator to run the line without all units being in the same gear ratio.

★ ★ ★

THE main prime mover of the system, that is the variable voltage drive, was equipped with operating features that were not normally provided in extrusion operation.

★ ★ ★

REMOTE acceleration control was provided so that a uniform acceleration rate to a predetermined speed could be used. This allowed the operator to have complete freedom from the task of controlling the acceleration rate which, if not carefully done, can result in wire breakage or in faulty jacketing.

★ ★ ★

IN case of an emergency, such as a wire break, dynamic braking is a useful safety feature. Dynamic braking was applied to the entire system and under those braking conditions, it was entirely possible to stop the entire line, under rapid deceleration conditions, synchronously.

★ ★ ★

IT was decided that the tuber synchronization should be completely independent from the means of synchronization of the wire speed. This was done because of the difference of delivery capacity of any tuber as compared to the straight line speed function of the wire drive. Accordingly, the tuber was also equipped with remote acceleration control so that it was easily possible for the operator, by electric pushbutton methods, to synchronize both the speed of screw and the speed of the wire for a given coating thickness.

★ ★ ★

IN a short space of time, it is possible only to hit the very broad aspects of the application of nylon to wire. We have been able to discuss only the broad equipment aspects of the two methods of applying nylon to wire or cable.

★ ★ ★

IN order to present a resume, it can be said that the solution method can be used under the following conditions:—

1) **For wires approximately 18 gauge and smaller.**
2) **For relatively thin coating thickness or thin applications.**
3) **Where space requirements do not permit the extrusion method, other things being equal.**

★ ★ ★

LIKEWISE, the extrusion method has its advantages when the following conditions exist:—

1) **Large diameter wires and cables are to be jacketed.**
2) **Heavy nylon coats are to be required.**
3) **Where insufficient headroom exists, all other conditions being equal.**

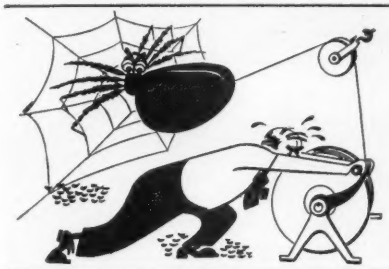
★ ★ ★

NATURALLY, these are not dogmatic statements, but rather they are the general summary of the conclusions reached after many specific discussions with insulating engineers, cable engineers, extruder manufacturers and others who are actively interested in Nylon Coating Application.

★ ★ ★

What's your problem?

Fine Wire? Tungsten? Molybdenum?



Problem 1

The firm of AL LOYS & AL UMINUM were in urgent need of fine aluminum and aluminum alloy wire for a delicate production job. Fine Wire Headquarters assured them that it was no problem at all The order was placed, the Fine Wire delivered, and it performed to the complete satisfaction of all concerned.

Problem 2

Mr. Hi Hott needed molybdenum sheets for forming into parts High hot strength and good ductility were required North American Philips supplied him with Elmet Molybdenum sheets that met his specifications exactly

Problem 3

Mr. N O Emission, II, required plated grid wires. He solved his problem with a call to Fine Wire Headquarters. We shipped him some gold plated tungsten and molybdenum wires. Result: no secondary emission.

the answer

WHY not call Fine Wire Headquarters when you have a question about fine wire? We can't do the impossible, but we can do lots of things that can bring you the right fine wire for the job. So—when you have a Fine Wire problem—wire, phone or write to North American Philips, makers of NORELCO Fine Wires, and ELMET Tungsten and Molybdenum products.

NORTH AMERICAN PHILIPS COMPANY, INC.

Factory and Main Sales Office: Lewiston, Maine

Export Representative · Philips Export Corporation · 100 East 42nd Street, New York 17, N. Y.

Possibilities in Handling Wire and Wire Products

(*Continued from page 940*)

direct to the pay-off stands back of the intermediates and loaded onto them ready for welding. These pay-off stands are novel in that they have the wire loaded on the back end where it can be welded to the bundle already there, without stopping the machine. This operation can go on indefinitely. The combination of the rod and intermediate machine eliminates several handlings and is the method to be used although the layout of the machines is such that either set-up may be employed as production requirements may require.

★ ★ ★

FROM the intermediate machines the coils will go to the annealers. This handling operation has yet to be worked out. Our problem here is how to best handle the wire. Shall we use fork lift trucks (gas or electric) or shall we use power driven platform lift trucks with the operator walking? Another problem is how best to load the annealing pins?

★ ★ ★

A LARGE portion of our wire is drawn after annealing to fine wire for screen cloth. The wire is delivered to the fine wire machines in 700 pound packages. Perhaps more can be said of this at some later date. The fine wire is drawn both in coils and on spools. Eventually all of this wire will be drawn on spools, and used without further respooling.

★ ★ ★

THE bulk of our wire not drawn to fine wire goes into poultry netting and is finished to size on the intermediate machines, annealed and galvanized. Here again we are going to modernize and we are confronted with another packaging and handling problem. We want wire delivered to the netting machines in approximately 1000 pound packages. Is it possible to galvanize onto a 1000 pound spool? We think it is. We have heard of wire being galvanized in coils and loaded directly onto combined skid and pay-off stand. In this case coils would be welded together to give the desired package. Both schemes have merit but which is the better?

★ ★ ★

ASIDE from the Wire Mill we are wondering what is the best method of handling and storing wire with the least handling? To utilize the cubic contents of a building you must stack, but what is the best size and design of a container and what is the most economical way to handle with limited storage facilities?

★ ★ ★

IN the Rope Shop how is the best way to handle and store reels of rope? Handling of the bobbins of wire from the spoolers to the stranders is also a problem. In this connection would it be possible to get rope wire on spools in place of coils? This would be especially advantageous if the spools would fit the stranders. These are some of the handling problems that come up. How many of you have some of the answers?

★ ★ ★

The quality of the wire you use governs the quality of your finished product. Laclede wire is made to your specifications . . . with quality that's controlled from their open hearth through the finished wire —assuring uniform temper, gauge and finish.

QUALITY WIRE FOR ALL NEEDS —IN ALL GRADES AND FINISHES

Bright or Black Annealed	Fine and Weaving
High Carbon Spring	Stapling Rope
Low Carbon Bright Basic	Bookbinding

Tinned, Galvanized Copper Coated—Liquor Finishes

Sizes: ½″ to 40 ga. (.007″)

Coils, Spools, or cut Lengths

Laclede engineers and metallurgists will aid you in developing wire specifications to better your product. Write for information.

LACLEDE
Producers of Construction Steel

LACLEDE STEEL COMPANY
St. Louis, Mo.

New Copper Alloy Developed by Battelle Memorial Institute

AN alloy of copper and silver which has both high electrical conductivity and high strength when drawn to wire or rolled into strip has been developed by metallurgists of **Battelle Institute,** Columbus, Ohio. It is being tested by the Army Signal Corps as a material for use in field communications wire. It is reported also that it may prove useful in radio and television.

★ ★ ★

WIRE made from the alloy has several advantages for Signal Corps use. It can be stretched greater distances between supports without breaking, is more easily handled, and conducts more electrical current. Because the stranded conductor is made of similar wires, manufacturing and splicing in the field is simplified.

★ ★ ★

THE development is the result of Signal Corps-sponsored research at Battelle. In 1946, the Signal Corps asked the Institute to investigate the possibility of devising a copper alloy wire which would have properties superior to its standard field wire. The latter, a stranded material, is made up of four copper wires and three steel wires, each about 1/100 of an inch in diameter. The copper wires carry most of the current and the steel wires give the strength. The use of two such dissimilar wires in the strand causes trouble in production and in splicing in the field. This would be avoided if all wires in the strand were alike.

★ ★ ★

BATTELLE metallurgists solved the problem by developing a copper-silver alloy and a method of heat treating and work hardening to give it high strength. (A 0.011-inch-diameter wire has a minimum tensile strength of 170,000 p.s.i. and a conductivity of 70% IACS.) The specially fabricated wire in laboratory tests exceeds all specifications for field communications wire. The silver content is about 6½ per cent, but in view of the properties obtained, the use of silver is not considered prohibitive.

★ ★ ★

OVER 50 miles of copper-silver wire have now been made by the American Brass Company for service testing. In all probability, the material will have numerous other uses in industry, according to **Dr. Bruce W. Gonser** and **Webster Hodge,** Battelle metallurgists in charge of the wire development. Radio and television are two fields in which applications are "most likely". In strip form, it is believed that the alloy eventually may be useful in instrument manufacturing, wherever a combination of strength, springiness, and electrical or heat conductivity is needed. To date, however, there has been no research on developing industrial uses for the wire alloy, the Battelle men were careful to point out.

★ ★ ★

BATTELLE INSTITUTE is one of the country's leading foundations for education and industrial research. It conducts research for private industry and governmental agencies on a nonprofit basis.

★ ★ ★

All Metal

WIRE SPOOLS

Light weight, all-steel, lithographed.
5", 6½", and 10½" diameter ends.
Ends and traverses may be shipped unassembled.

We also produce spools for fine and magnet wire.

J. L. CLARK MANUFACTURING CO.
600 23rd AVENUE • ROCKFORD, ILLINOIS

Processing of Stainless Steel Wire

(*Continued from page 923*)

die. Stainless generates more heat when drawn than carbon steel and consequently lubricants which are suitable for drawing carbon steel may not be satisfactory for stainless. In most cases it is the desire of the wire drawer to secure as smooth and as high a finish on stainless as possible. The ultimate in finish is achieved when drawing is accomplished with no lubricant as the surface is then in direct contact with the die which results in a burnishing effect that produces a high lustre. From a practical standpoint, it is not possible to draw dry and bare stainless steel wire as it will pick-up on dies which results in scratched wire. In drawing stainless through diamond dies the wire is generally bare as it enters the die tub, but as the dies are covered with an oil or water lubricant the surface is lubricated to some degree. Diamond drawn wire has a high lustre which is desirable in many applications.

★ ★ ★

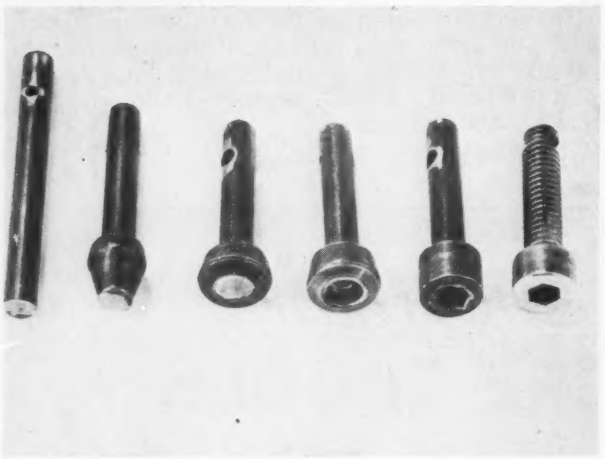
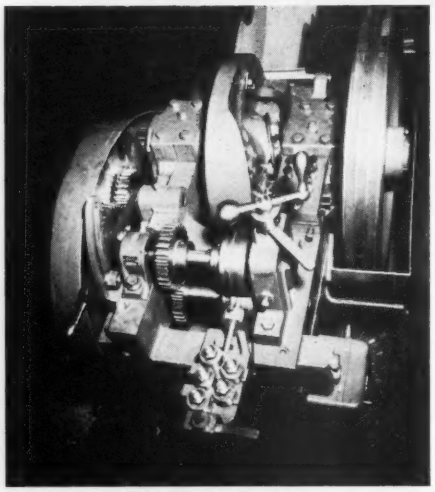


Fig. 16—Processing steps in making 18—8 stainless steel set-screws on multiple die up-setter. This type operation requires highly uniform wire, with low work hardening rate.

Fig. 17—Careful handling of stainless steel wire is necessary in every processing operation. Wooden skids prevent much scratching by concrete floors and general handling.

1000 STAPLES PER MINUTE!!!



Top View, showing
Fly Wheel and Gears

FENCE STAPLES—POULTRY NETTING STAPLES—
DOUBLE POINTED TACKS (WIRE CLOTH TACKS)

Fastest Staple Cutter Ever Made — Makes Two Complete Staples at each revolution — Compact, Easily Adjustable, Efficient.

48 Different Leg Lengths, Gauges 9 through 18

Can Be Made With

HUMPHREY RAPID STAPLE CUTTER

Early Deliveries of Belt or Motor Drive Machines Now Possible. Send for complete details and prices.

Manufactured Exclusively For

REED and RICHARDS TRANSATLANTIC, INC.

CHANIN BLDG., 122 EAST 42nd ST., NEW YORK 17, N. Y., U.S.A.

REG. CABLE ADD., "LOUREED, NEW YORK".

Also Bale Tie Machines, producing single loop, round or oval ties, 2000 per hour; 3 to 16 ft.

MANY proprietary drawing compounds have been introduced for drawing stainless but in the main there has not as yet been developed a universally satisfactory lubricant for drawing stainless. As mentioned earlier, pure lead, put on by hot dipping in coils or strands is about the best lubricant for roughing and heavy drafts. Lead is relatively expensive and must be removed before process annealing. Very little tonnage of lead coated wire is shipped to users, although it is an excellent lubricant for spring and cold heading wire. However, there is some indication that the use of lead presents a health hazard as dangerous concentrations may build up in the atmosphere around high speed tandem draw benches. Adequate ventilation should be provided for such installations.

★ ★ ★

LIME, the workhorse of drawing compounds, is used extensively for drawing stainless. The best grade of slaked lime as a saturated solution in hot water is used and applied to the wire by dipping. A thin, tightly adherent coating is desired which will act as a lubricant as well as a base for carrying grease, soap or other lubricants into the die. It is not generally

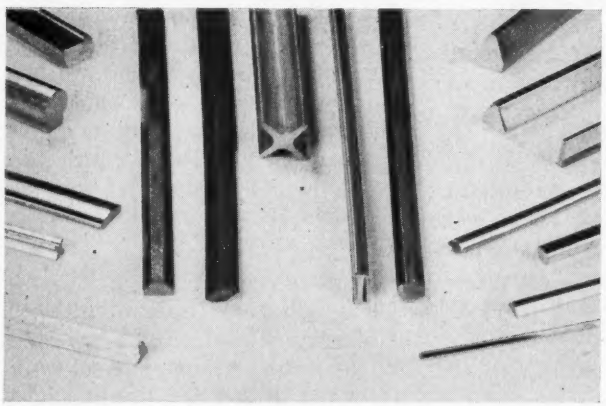


Fig. 18—Typical sections being made from stainless steel wire by cold drawing and rolling. * * * * * * *

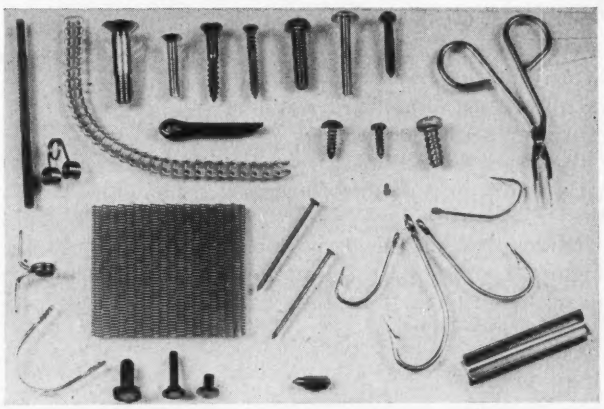
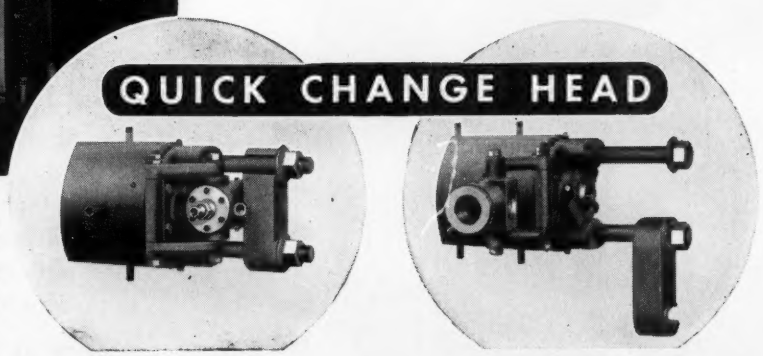


Fig. 19—A few of the many hundreds of applications where stainless steel wire is serving industry, the home and the individual. * *

NE Quick Change Head Unit permits swinging Die Head out, for cleaning, inspection or changing. Just loosen 2 bolts. This feature illustrated on a 3½" NE Tuber is available on all sizes thru 6"

NE TUBERS *adaptable to* **variety of products. Illustrated at left is a 4½" NE tuber equipped with cross-feed flanged-type head for insulating wire, extruding hose covering, special shapes or tubing. With slight modifications, either rubber or plastics can be handled.**



NATIONAL-ERIE CORPORATION

ERIE, PA., U.S.A.

necessary to remove lime from wire prior to process annealing, as it tends to minimize scaling. Lime coated wire as such is not generally shipped to the user, although lime coated wire which has been drawn through soap in die box is used for cold heading, and most wire for electrode use receives a lime coating prior to shipment.

★ ★ ★

IT is general practice to have soap and other lubricants in die boxes when dry drawing stainless wire. Many proprietary compounds with soap as a base are available to wire drawers, but regular white flake high purity soap is quite satisfactory as a die box lubricant. Most cold heading wire is finished with soap in the die box, and it augments other coatings used as lubricants in cold heading and forming operations.

★ ★ ★

COPPER, applied by electro-deposition, has proven highly satisfactory as a lubricant for cold heading and forming operations. In producing stainless cold heading wire it is general practice to draw .003″ to .005″ oversize, process anneal, pickle, copper coat, light lime, and draw to size with soap in die box. For cold heading operations a heavy copper coat is undesirable and best results are obtained when the coating is between .0003″ and .0005″ and tightly adherent. Prior to the plating operation it is necessary to treat wire in a hot hydrochloric acid solution to secure good adhesion. Copper is not generally used as a lubricant for heavy drafts.

★ ★ ★

IN recent years, proprietary grease compounds have come into wide use for drawing stainless, particularly for light passes, to impart a smooth and lustrous finish to the wire.

★ ★ ★

TIN, cadmium, and cadmium base alloys are sometimes applied to the surface of stainless steel for special uses. Tin is used on armature binding wire to assist in soldering; cadmium has been used on spring wire to facilitate automatic winding but due to high cost it has been replaced largely by other materials. "Oxide" coating on wire has proven beneficial for some years as a lubricant for spring and cold heading operations.

★ ★ ★

IN addition to the forming of shapes from wire by cold drawing, cold rolling is used for making shapes from wire which are not practicable to produce by drawing. Almost any shape which can be made of carbon steel can be produced in one of the stainless grades.

★ ★ ★

IT is necessary to maintain close laboratory control of every step in processing stainless steel wire from rod to finished size as slight variations in analysis and drafting have considerable influence on the

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tensile properties of the finished wire. As mentioned earlier, users of stainless steel are becoming more critical in their demands as to quality and uniformity, which in turn require the producer to tighten his processing controls. As compared to carbon steel, stainless is an expensive engineering material, and the user is apt to complain if any appreciable scrap results in his operations. The toughest problem is uniformity of tensile properties, especially of the chromium-nickel grades. These grades harden rapidly and to a high degree when cold deformed, such as by drawing, and small variations in size and analysis will result in wide differences of tensile properties in finished wire.

★ ★ ★

SELECTION of analysis is important, particularly with the chromium-nickel alloys, as the ratio of carbon to chromium to nickel has a profound influence on the reaction of these alloys to cold deformation. Carbon is not as important as chromium and nickel, as it is generally low, under .08%. Type 302, or 18-8, stainless is generally supplied with chromium about 18.5% and nickel 8.50%. If the nickel is raised in this base analysis to about 10.50%, the work hardening rate is decreased materially and this type of alloy is very satisfactory for applications involving cold deformation, such as making screws. On the other hand, if the nickel is lowered to about 7.50% the work hardening rate is increased considerably, and this type analysis is used for spring wire where high tensile properties are required. Between these two extremes are dozens of analysis combinations possible which introduces the problem of processing different lots of chromium-nickel stainless wire and ending with a product uniform in tensile properties. For this reason it is usually not possible to set up a standard drafting practice on a given size wire if the tensile requirements are to be held within narrow ranges. The only alternate is frequent tensile testing and adjust finishing drafts to accommodate the work hardening characteristics of each individual lot.

★ ★ ★

THE analysis of the chromium grades has very little bearing on work hardening rates, and standard drafting practice can be set up for these alloys.

★ ★ ★

TO assure satisfactory use in customers' plants, the surface of stainless wire should be protected during transit. Paper wrapping, burlapping, and boxing are used, depending on the users' preference.

★ ★ ★

SINCE the commercial introduction of stainless steel its use has extended into practically every industry, and it is a rare home that doesn't have one to several dozen articles made of this versatile metal. Many are made from wire, and the field of application for stainless steel wire is expanding each year. It is a well recog-

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nized fact that the cost of deterioration of steel by rusting amounts to many millions of dollars each year, and this occurs despite the use of paints, plating, and other methods of surface protection. The obvious answer to this problem is to use corrosion resisting steels, but the economics do not always justify their use. However, there are many applications where the overall saving in maintenance and repairs makes the use of stainless steel economical even though the first cost is higher than other less corrosion resisting materials.

★ ★ ★

Celsius Versus Centigrade

THE Ninth General Conference on Weights and Measures, held in October 1948, adopted the name "Celsius" for the scale of temperature which has more commonly been called "Centigrade." This action, which had not been proposed in advance of the Conference, arose from a question regarding preferred usage in French, the sole official language of the Conference. The decision therefore may be considered as applying strictly only to that language. In the interest of eventual uniformity of practice the use of "Celsius" appears desirable, but it is not practicable to impose this term on those who prefer "Centigrade."

★ ★ ★

WITH regard to the merits of the decision it may be remarked that Celsius (abbreviated C) is analogous to the names Kelvin, Fahrenheit, Reaumur and Rankine used for other temperature scales, that it has previously been used considerably in some countries, and occasionally in America, being included in Webster's dictionary. It might also be argued that "Centigrade" is logically ambiguous, since the absolute Kelvin scale, as well as the "Centigrade" scale, has 100 degrees between the ice point and the boiling point of water. On the other hand, the name "Centigrade" is thoroughly established in English-speaking countries, the need for choosing between that name and "Centesimale" arises only in French, and the decision on a term in the official French language of the Conference may not be considered as controlling the terms to be used in translating into other tongues.

★ ★ ★

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ANNOUNCEMENT has been made of the removal of the executive offices of **The Electric Industrial Truck Association,** to the Beury Building, 3701 North Broad Street, Philadelphia 40, Pennsylvania.

★ ★ ★

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★ ★ ★

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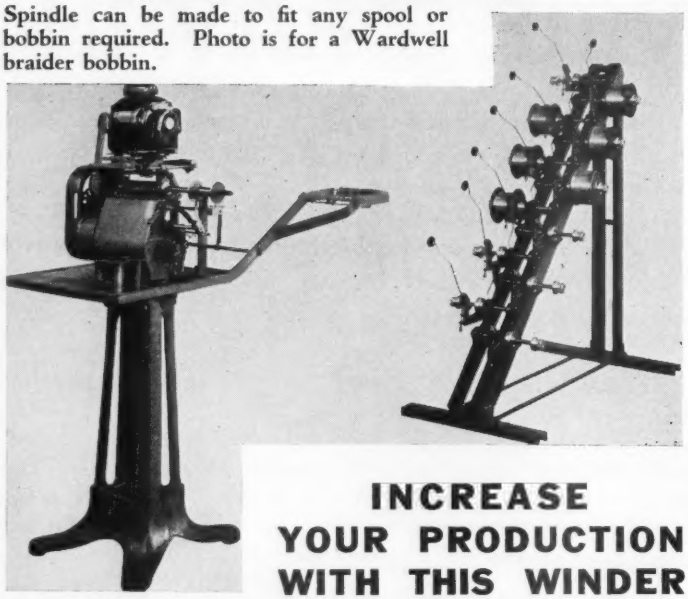

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Spools for Shipping Magnet Wire

(*Continued from page 890*)

ALUMINUM BRAZED SPOOL

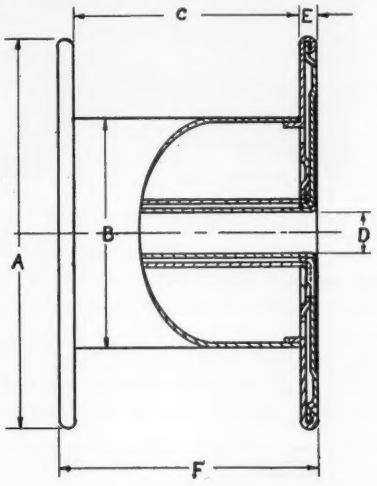


Figure 6

Wood-Metal Spool

THIS spool has only two factors in its favor, low cost and durability. As most wire mill men know this spool has been the standard for many years. However, due to its failure to meet the high standards now desired by the industry for concentricity, strength, continuity of surface and relatively poor appearance, it has been replaced by other types of spools.

★ ★ ★

Two Piece Aluminum Die Cast Spool

FOR a while this spool was accepted by the industry because it gave greater accuracy, was stronger, had better appearance and good continuity of surface. However, the higher value, high maintenance costs and poor resistance to breakage and nicking soon turned opinion against it.

★ ★ ★

One Piece Magnesium Die Cast Spool

THIS spool having more resiliency than the aluminum spool

ALUMINUM DRAWN SPOOL

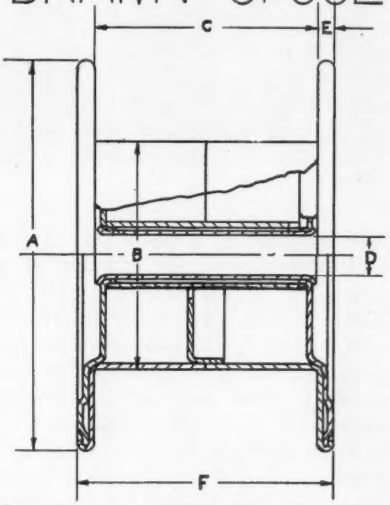
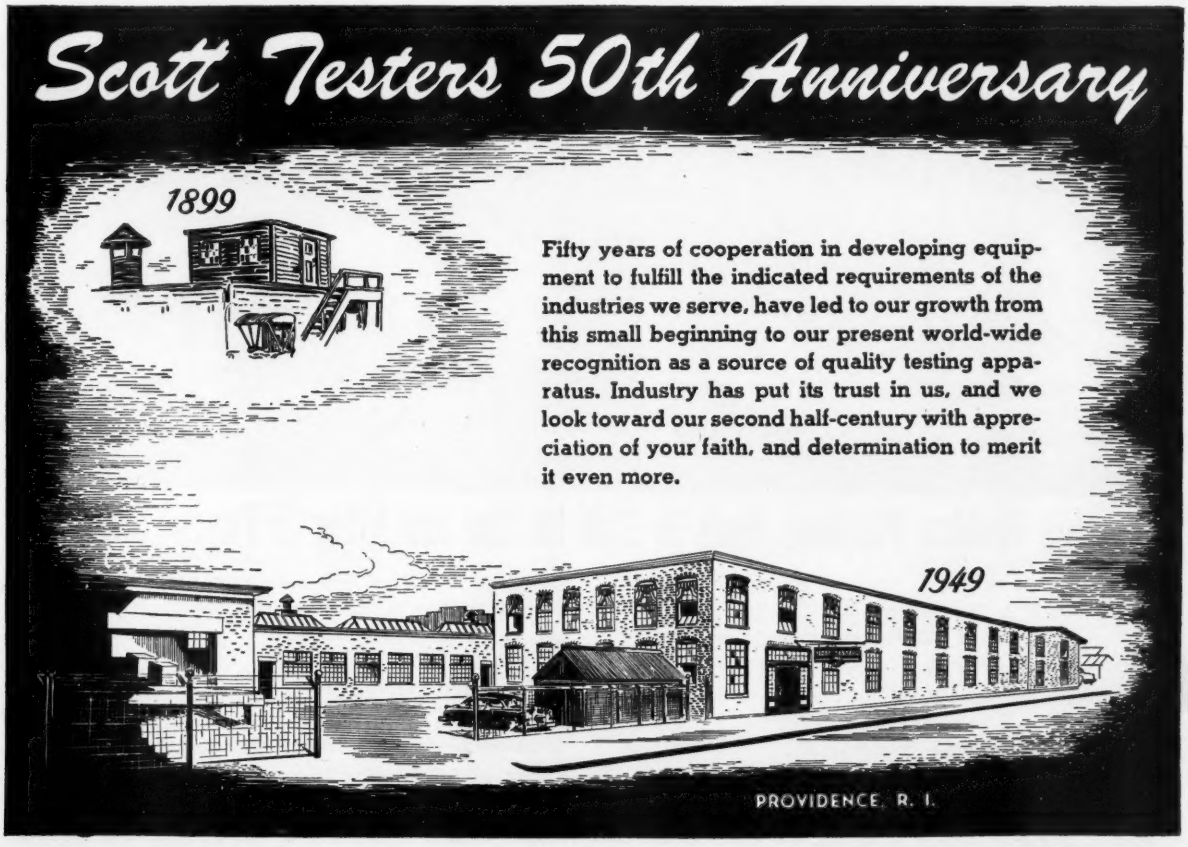


Figure 7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Fifty years of cooperation in developing equipment to fulfill the indicated requirements of the industries we serve, have led to our growth from this small beginning to our present world-wide recognition as a source of quality testing apparatus. Industry has put its trust in us, and we look toward our second half-century with appreciation of your faith, and determination to merit it even more.
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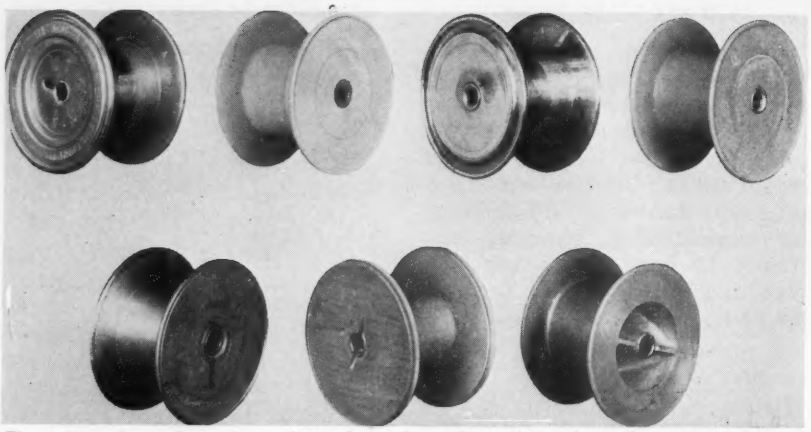


Figure 8

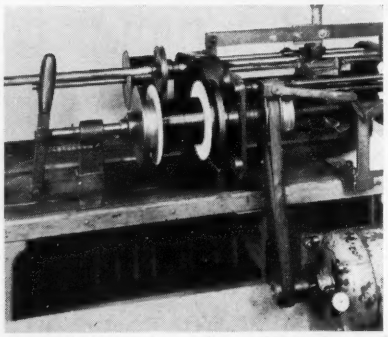


Figure 9

was started as a development for a lighter spool. As can be seen from the evaluation this appears to meet all requirements with the exception of being only fair in appearance and just good in close tolerances. Die cast spools, unless machined after die casting which always adds to the cost, will have greater tolerances than other types of spools due to the inherent nature of manufacture. It can be said that the development program is being carried on in this type of spool to produce a better finish.

★ ★ ★

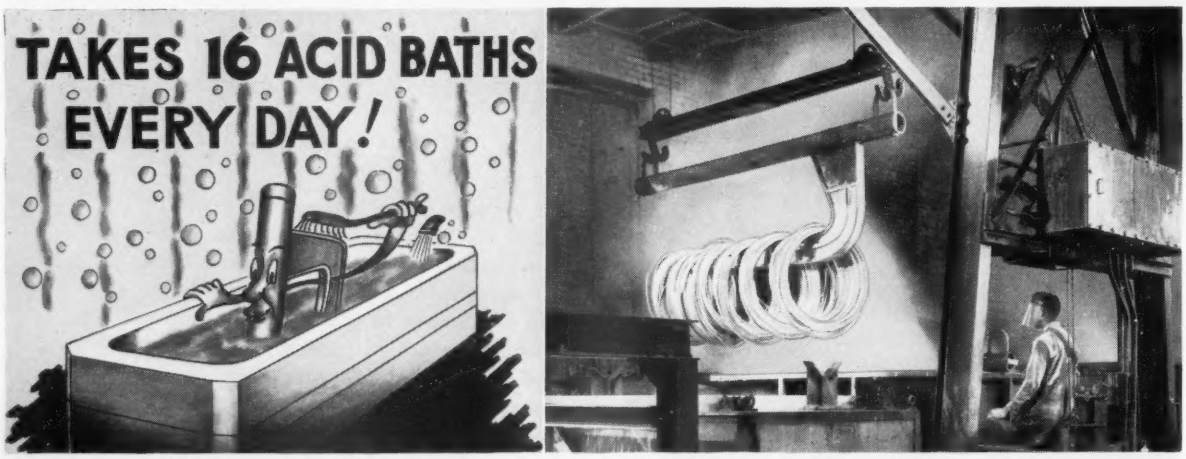
Sheet Aluminum Drawn Spool

WHILE the magnesium spool was in the process of development, the sheet aluminum drawn spool became the accepted standard of the industry. It can be seen easily why this happened. The spool, although high in cost and in maintenance upkeep, had very good accuracy, strength, appearance and continuity of surface. It increased production and met with great favor. However, as mentioned elsewhere, at times, it cost about ten cents per spool to straighten them since they bent so easily.

★ ★ ★

Sheet Aluminum Brazed Spool

IN order to eliminate all joints on the working surface and in order



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to try to reduce maintenance cost from bending of the heads of the spool, an aluminum spool was constructed from heat treatable brazing aluminum sheet. Since brazing of aluminum is relatively new in industry this was quite a venture. Finally a brazed aluminum spool was obtained which did eliminate to some extent the difficulties encountered with the drawn aluminum spool made from work hardening sheet, but the cost was still high.

★ ★ ★

Thermoplastic Spool

A NATURAL step in this development was to try plastics next. The thermoplastic spool designed and made seemed to be ideal in every respect and apparently was the answer. Low cost and excellence in almost every feature certainly aided in the early prom-

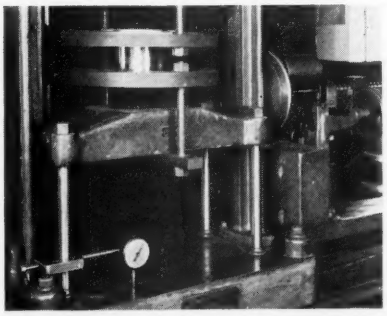

Figure 10. * * * * * *

ise of this spool. However, in the winding test, the spread of the flanges was objectionable as was the fact that when the spool was allowed to set at 90°F. for 72 hours, the heads spread even more. This was due to the cold flow characteristics of thermoplastic materials.

★ ★ ★

Fibre Glas Spool

ONE step towards plastic spools proved to be in the right direction for it led the designer to the fibre glas spool which thus far has fulfilled all the needs of a good shipping spool and all this, with only a medium priced spool. All tests to date show this spool to have excellence in accuracy, appearance (it can be produced in any color or combination of colors), durability, continuity of surface and dimensional stability. The strength is good and the weight is low. Thus it appears as though this spool could easily become the standard spool of the industry making use of the modern materials available to it. It is realized that all types of spools mentioned in this paper will continue in use for some time for as everyone knows the final selection of the spool will always be in the hands of the mill men.

★ ★ ★

IN conclusion, although this paper summarizes a study of the various types and designs of spools to be used by magnet wire industry for shipping fine wire, it is hoped that some degree of standardization will be obtained in the industry. As it is now there are as many types and designs of spools as there are mills. From the results obtained in the foregoing analysis and evaluation, this standardization should be on either the light alloy spool—either magnesium or aluminum—or on the Fibre Glas spool.

★ ★ ★

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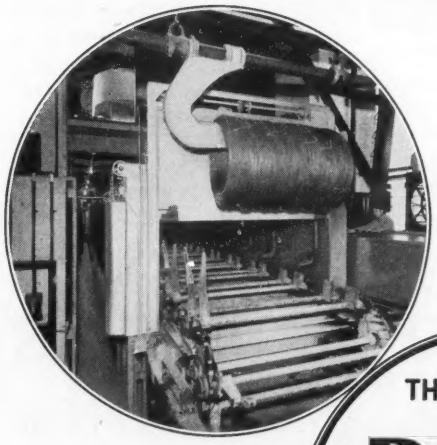

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operates the entire process even to raising and lowering oven doors without manual handling.

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Protective Atmospheres for Annealing Non-Ferrous Wire

(*Continued from page 864*)

furnace. Therefore carbon dioxide should be completely removed from all bright annealing gases which are dehydrated at the gas generator and which must remain dry in the furnace. Such precautions would seem to be desirable for bright annealing the nickel-silver alloys and the brasses and is a necessity for bright annealing the silicon brass or bronze alloys.

★ ★ ★

Clean Annealing vs: Bright Annealing

THE very exacting requirements for protective atmospheres used in true bright annealing has led to a careful study of the relative advantages of bright annealing over clean annealing at various stages in the production of these non-ferrous wire products. This is truly an economic problem, as the protective atmospheres required for clean annealing are invariably cheaper to produce and involve less costly generators than do atmospheres for bright annealing. There are other reasons for giving this matter serious consideration. In many cases of intermediate anneal, it is a distinct advantage to flash pickle the wire before the next drawing operation. Under such conditions a clean annealed product is entirely satisfactory and in fact is often beneficial inasmuch as it provides a slightly roughened surface for the next forming operation.

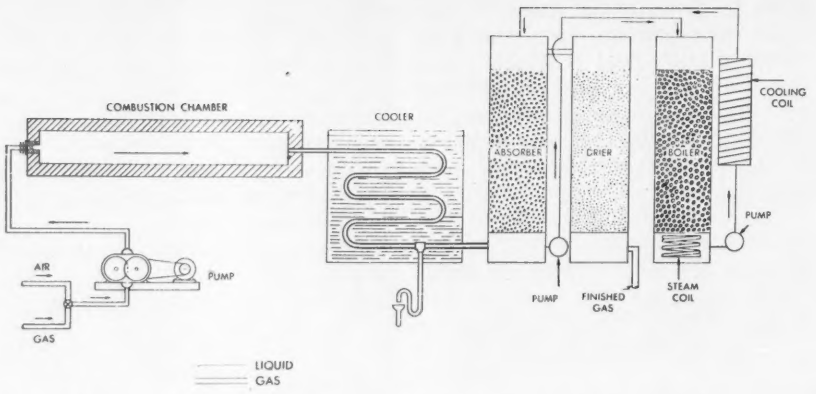

Figure VII—NX Gas Generator—Flow Diagram—Schematic diagram of nitrogen atmosphere generator.

★ ★ ★

SOMETIMES a final drawing operation follows the last anneal. This may eliminate the neces-

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sity for true bright annealing in the final heating operation if a study shows that clean annealing plus flash pickling is a cheaper operation. In most cases however, the final anneal can profitably be carried out in a bright annealing atmosphere and this practice is finding wide acceptance in the non-ferrous industry as a whole.

★ ★ ★

IN the non-ferrous wire industry the manner in which the product is handled through the furnace often times has a distinct bearing on the type of atmosphere required for the desired degree of surface protection. Invariably the heating and cooling of wire products in coil form requires a better quality of protective atmosphere for any desired result. The allowable dew point of the atmosphere gas depends to a large extent upon the rate of cooling of the metals from their maximum temperatures. There is a critical temperature range in which they are most susceptible to oxidation by water vapor. Above this temperature, progressively larger concentrations of water vapor can be tolerated because of the increased activity of the hydrogen as a reducing agent. Below the critical temperature, the rate of oxidation by water vapor gradually diminishes until it becomes negligible at room temperature. Extremely fast cool-

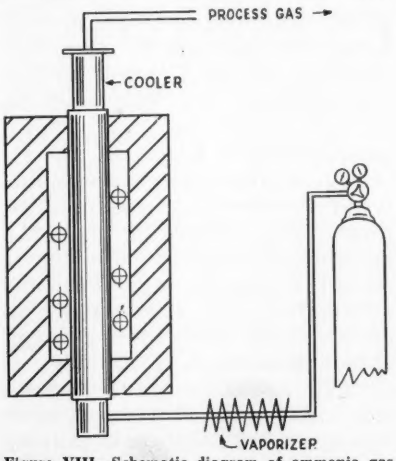

Figure VIII—Schematic diagram of ammonia gas dissociator.

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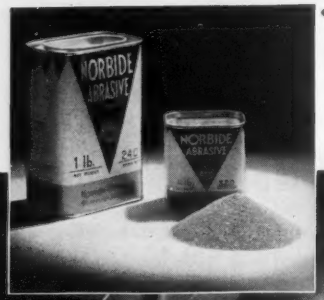

This abrasive—second only to the diamond in hardness and 150 times less expensive—does an efficient job of cutting and semi-finishing cemented carbide wire drawing dies.

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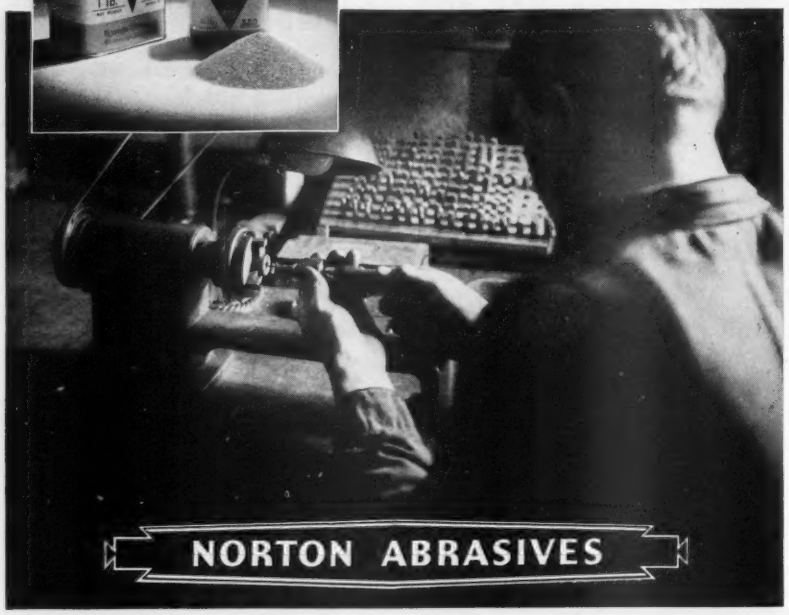

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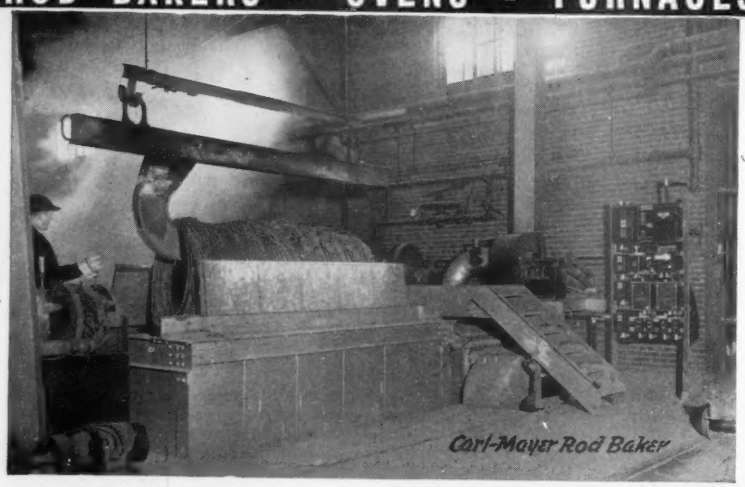

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ing rates as when single strands are treated permit considerably higher dew points in the bright annealing furnace atmosphere than when slower-cooling coils are annealed. The temperature for critical oxidation of zinc-containing alloy will vary somewhat with the analysis of the alloy but will usually be in the range of 1000° F. to 1150° F. In view of this fact, it is often possible to water quench bright annealed zinc-containing wire without sacrificing the bright finish on the wire. On the other hand, bright annealed coils are never possible without complete dehydration of the protective atmosphere supplied to and maintained in the heating and cooling zones of the furnace. As mentioned previously, carbon dioxide in the heating chamber will produce water vapor so it must be eliminated from the true bright annealing atmosphere. Carbon monoxide under the influence of heat will break down into carbon dioxide and free carbon, thus providing an additional potential source for water vapor and a possible carbon deposit on the work surfaces.

★ ★ ★

IT now appears that the manufacturer of non-ferrous wire containing easily oxidizable elements as zinc, silicon and beryllium must base his protective atmosphere generator requirements upon surface finish and upon the method of handling through the furnace.

★ ★ ★

FOR single strand bright annealing and particularly for clean annealing, so called "rich" air-fuel gas mixtures are combusted in generators of the type shown schematically in Figure 6. The atmosphere from this generator differs from the "lean" gas used for copper and nickel in that the amounts of reducing constituents carbon monoxide, hydrogen and hydrocarbons are substantially increased while the oxidizing agent, carbon dioxide, is materially reduced. In addition the generator gas is deprived of its water vapor by passing through the primary cooler, refrigerator and finally, the

activated alumina dryer to lower the dew point to —40° F. or below. The analysis of this "rich" atmosphere as produced from natural gas, will be approximately:

CO_2 — 4.0-50%
O_2 — 0.0
CO — 8 -10%
CH_4 — .5-1.0%
H_2 — 10-12%
N_2 — Balance

★ ★ ★

FOR true bright annealing of these easily oxidized alloys in coil form, the "rich" protective atmosphere falls short of complete protective qualities. True, the water vapor has been eliminated but carbon monoxide and carbon dioxide remain in substantial quantities to produce both water vapor and free carbon in the furnace. Therefore, the ultimate in generated protective atmospheres calls for practically complete elimination of both carbon monoxide and carbon dioxide.

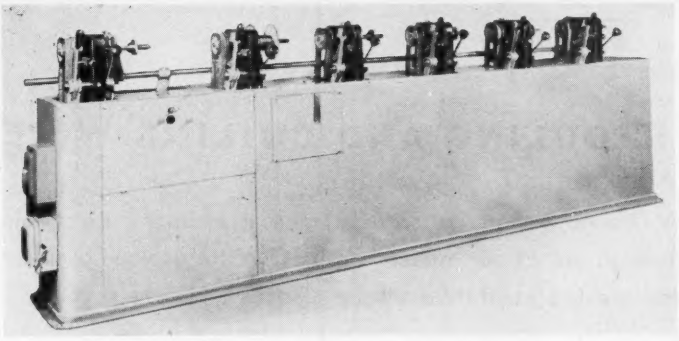
★ ★ ★

AT the present time, two most successful types of bright annealing atmospheres are produced from quite different sources. In one case, air-fuel gas is burned to almost complete combustion, thus eliminating all but traces of carbon monoxide and hydrogen. The carbon dioxide is then removed by absorption in a suitable medium usually one of the amines. After carbon dioxide removal, the gas is dried by passing through a refrigerator and then through some desiccating agent as activated alumina to produce an inert gas with a dew point of —40° F. or below. The typical atmosphere produced by a generator schematically shown in Figure 7 is as follows:

CO_2 — Trace
O_2 — 0.0%
CO — 0.5% minimum
H_2 — 0.5% minimum
CH_4 — Trace
N_2 — 98-99%

★ ★ ★

A SECOND type of protective atmosphere is produced by the dissociation of ammonia with or without subsequent partial combustion of one of the dissociated products. When anhydrous am-



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monia vapor is heated to about 1700° F. in a suitable retort as shown schematically in Figure 8, the ammonia dissociates into its elementary gases nitrogen and hydrogen in the ratio of one of the former to three of the latter. Thus a protective atmosphere gas is produced which contains approximately 25% nitrogen and 75% hydrogen and moisture equivalent to a dew point of —60° F. or below. The highly reducing power of this gas will be readily recognized.

★ ★ ★

FOR economic and safety reasons dissociated ammonia is usually partially combusted before being used as a protective atmosphere. By adding a controlled amount of air any desired amount of the hydrogen can be burned to form water vapor. Almost any ratio of hydrogen to nitrogen can be obtained as shown in the Table A.

TABLE A

Ratio Air: Dissociated Ammonia	Product H_2	Product N_2
No air	75%	25%
.5 :1	45%	55%
1 :1	35%	65%
1.5 :1	10%	90%
1.75 :1	3%	97%

★ ★ ★

THE equipment required for producing partially burned dissociated ammonia consists of the dissociater just described and an additional retort for burning the air-gas mixture. The construction of this latter chamber will depend upon the residual hydrogen desired. If more than about 20% hydrogen is required, the deficiency of air will be so great that external heating will be required to provide sufficient heat energy. If the hydrogen content is below 20% and it usually is, it is possible to utilize the heat of combustion of the mixture and to eliminate external heating. From 5% to 10% hydrogen provides a substantially non-explosive gas with sufficient reducing power to take care of most annealing applications. Naturally the reduction of hydrogen by combustion is accompanied by the forma-

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tion of water vapor which must be removed if low dew points are required. Drying means have been described in connection with generators previously mentioned.

★ ★ ★

Conclusion

IN concluding it is most evident that the producer of non-ferrous wires has a wide variety of protective atmospheres to choose from. Certain fundamental principles are involved in making the proper selection of the atmosphere. Also, the problem of most economical but satisfactory operation should influence the choice. It is only by giving serious consideration to these and other pertinent matters, including proper furnace construction that optimum results can be obtained by the use of any protective atmosphere regardless of its type or method of preparation. The non-ferrous wire industry has shown marked interest in the development and use of protective atmospheres and its continued enthusiasm in these respects will undoubtedly lead to further improvements in methods for providing truly protective atmospheres for annealing purposes.

★ ★ ★

Westinghouse Electric Appointments

WESTINGHOUSE ELECTRIC CORP., Pittsburgh, announces the following appointments: **G. L. MacLane, Jr.** has been named manager of the engineering laboratories, succeeding **Thomas L. Spooner,** who retired after 40 years' service with Westinghouse. **James E. Woodall** has been named manager, Fairmont, W. Va., plant of the Lamp Division, and **John Rosevear,** former manager at Fairmont, becomes staff assistant to Mr. Woodall. Two executive appointments in the industry sales departments are: **R. S. Kersh,** named manager of central station sales, and **F. D. Weatherholt,** appointed manager of industrial sales. Both will be located at the East Pittsburgh plant.

★ ★ ★

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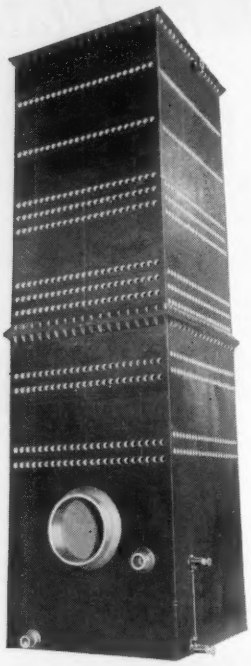

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Back Pull Wire Drawing

(*Continued from page 885*)

the maximum safe drafting with back pull seemed to be about 30% per hole.

★ ★ ★

LESS reduction in area per hole means more dies for the same work. It is believed that the disadvantage of more dies will outweigh any advantage which might come from the use of back pull such as greater die life or reduced horsepower. In other words, there does not seem to be any particular advantage in using back pull for drawing low carbon steel.

★ ★ ★

SUMMARY

THE various aspects of back pull wire drawing may be briefly recapitulated as follows:

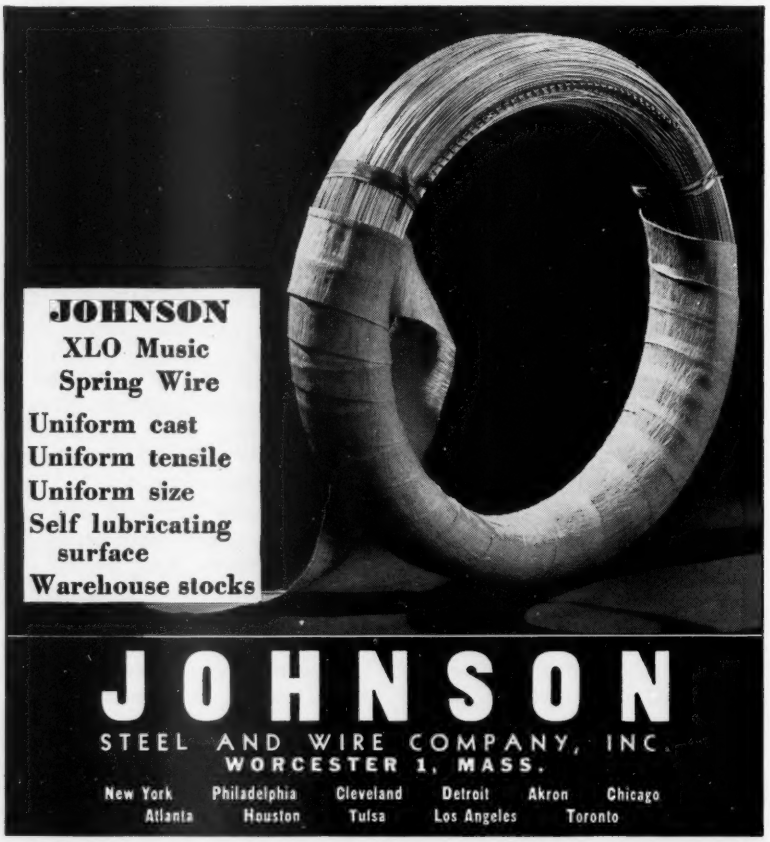
1. For the first time a practical wire drawing machine capable of controllable back pull has been made available to the wire industry. Even though deliberate back pull may not always be desirable, this machine has some very useful features apart from back pull, as follows:

   a) **Wire passes directly through the die from block to block.**
   b) **Block speed adjustment is automatic.**
   c) **Any reduction of area from 0% up may be used on any block.**

TABLE II

Series M—.187″ Diameter Rod. Drawn 5 holes to .078″ diam. wire. Average reduction per hole 30%. Total reduction 82.5%. All blocks filled to puller slots.

Series	Machine	Speed F.P.M.	Back Pull	U.T.S. p.s.i.	Recov. Elong. 10″—%	R.A. %
M	Conventional	1400	0	107,900	0.7	60.5
M-1	M-R	1365	Min.	108,900	0.7	59.8
M-2	M-R	1195	Min.	110,000	0.8	59.0



d) Die pull is indicated directly in pounds for each die.

2. The use of back pull alters wire drawing as follows:

a) Lower pressure between wire and die (reduction of 1/3 is practicable).
b) Longer die life (amount not determined).
c) Less horsepower (about 7%).
d) Lower wire surface temperature.
e) Increased forward pull.
f) Increased weld breakage.

3. The effect of back pull on quality of high carbon wire is to reduce the percentage of split torsions (because of lower wire temperature) and to reduce the ductility as measured by bends and reduction of area. (Forward pull should not exceed 50% of T.S. otherwise R.A.% may fall below 40% and there is danger of cuppy wire if forward pull is too high.)

★ ★ ★

4. There does not seem to be any particular advantage in using back pull drawing for low carbon wire.

★ ★ ★

ACKNOWLEDGMENTS

George A. Goetz, Development Engineer, with John A. Roebling's Sons Company, who carried out the experimental work here reported.

The management of John A. Roebling's Sons Company has taken considerable interest in this investigation and their permission to publish the results is much appreciated.

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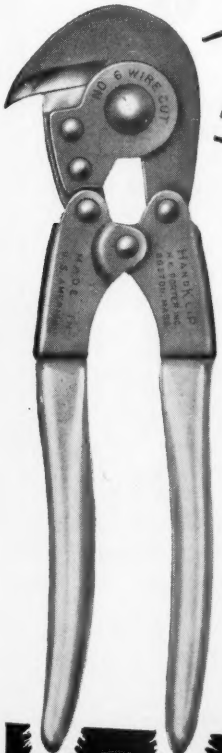

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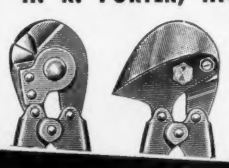

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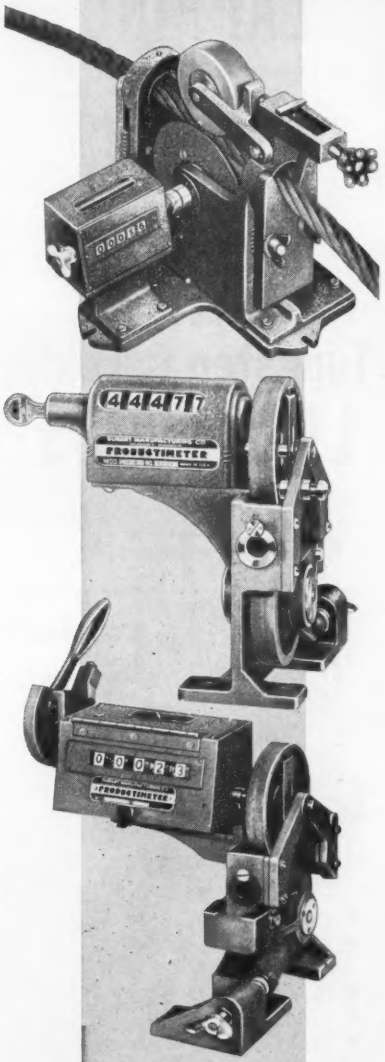

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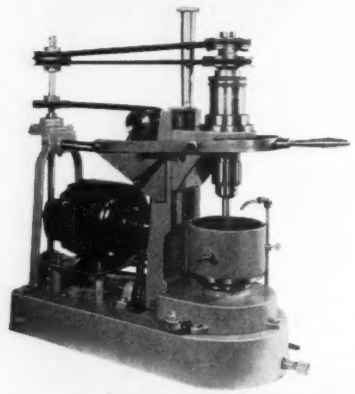

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Welding in the Wire Industry

(*Continued from page 872*)

mediately after rod end preparation would minimize the presence of this oxide line. From this point on, the time between rod end preparation and welding was less than 5 minutes.

★ ★ ★

COMPLETE elimination or diffusion of the line was the next project, and three lines of investigation were followed:

1. **Diffusion through heat treatment.**
2. **Use of other gases such as CO and HCl.**
3. **Beveled end preparation with greater upset.**

A 20-minute heat treatment at 2000° F. diffused and obliterated the oxide line. Fig. 16 shows where the line once existed.

★ ★ ★

CARBON monoxide and hydrogen chloride were tried in an effort to eliminate the oxide film by chemical reaction. The carbon monoxide might react with the oxygen to form dioxide. The hydrochloric acid gas might react as follows:

$$2HCl + O + Fe = H_2O + FeCl_2$$

At welding temperature the products of reaction would be in the gaseous state.

★ ★ ★

THE rod ends were beveled with a 1-1/8" radius so that the gases would have an opportunity to react. The welding procedure was to momentarily preheat the rod ends by keeping them in contact but under no positive pressure. After the initial heating the rods were momentarily permitted to cool before the welding took place.

★ ★ ★

WELDS made in carbon monoxide had much less of an oxide line than those made in H_2. Welds made in HCl contained as great an oxide line as those made in H_2. From this point on, all the welds were made in carbon monoxide.

★ ★ ★

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the oxide line by chemical reaction were futile, another line of attack was employed. The use of a small

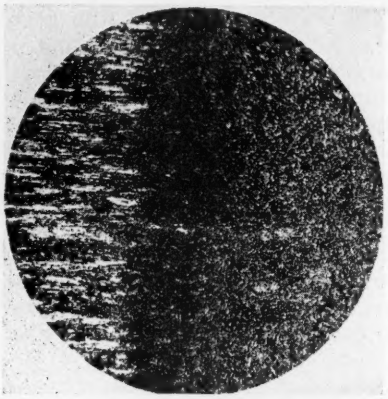

Fig. 17—Photomicrograph of insufficient anneal in .040" diameter Improved Plow Rope Wire.

contact area which, when upset, would be enlarged at least to the diameter of the rod and result in distributing the oxide over several times its initial area. One drawback to this method would be that the longitudinal direction of the flow lines would be greatly altered.

★ ★ ★

WELDS made with this bevel contained much less oxide than previous ones but were not completely free from it. The oxide

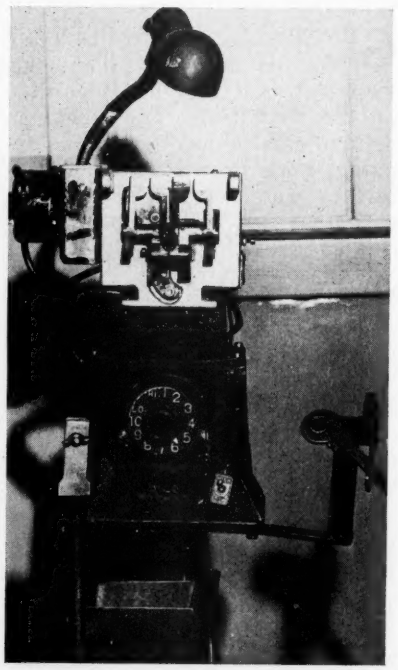

Fig. 18—View of Automatic Welding Head.

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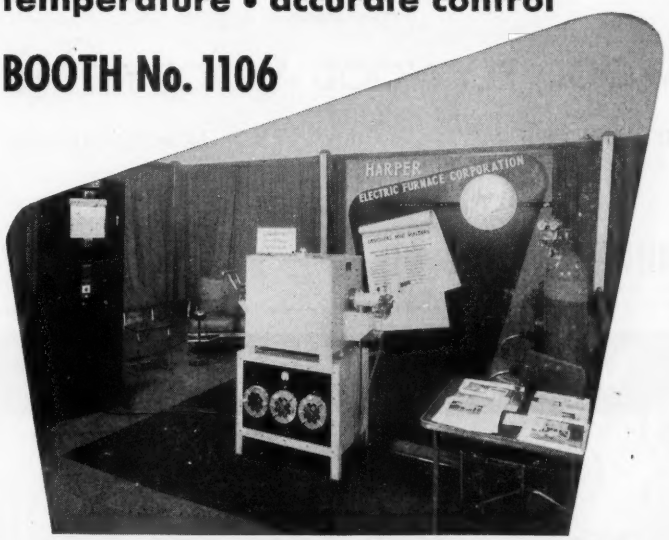

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in these welds was still generally present across 25% of the rod diameter.

★ ★ ★

TO go a step further, the glass window was removed and a large rubber balloon containing a small file was slipped over the open window. After a purging of the chamber and balloon with CO, the file was inserted into the chamber and the rod ends filed. Theoretically a new surface had been exposed in a reducing atmosphere so that no oxide could form. Welds made in this manner still contained remnants of the oxide line.

★ ★ ★

FROM a microstructural viewpoint, complete elimination of the oxide was not attainable unless a high temperature was employed to diffuse the oxide line.

★ ★ ★

THE next step was to make, heat treat, wire draw and test the welds. For this part of the work several groups of welds were made.

★ ★ ★

THE treatment of each group as well as the results of the wire drawing are described in Table III.

★ ★ ★

GENERALLY the weld failed in the die and the failed ends were flat as if they had separated on the weld face. The welds, in spite of care in making and the apparent grain growth across the interface, were not as well stuck together as had been supposed.

★ ★ ★

TENSILE tests and wrap tests were performed on those welds which did wire draw. Of those which were tensile tested, the strengths were very close to the original material; of those wrap tested, only about one-half accepted the test.

★ ★ ★

UP to this point only .80% carbon wire had been investigated. Thinking that a lower carbon, .65%, would be better, pressure welds were made in this material. The welds were made in

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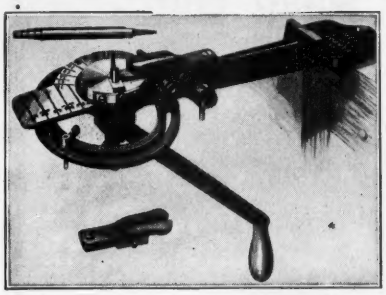

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H_2 with 1/8" upset, forged back, patented, and wire drawn. Of 30 welds, 15 failed in wire drawing. Eleven welds were wrap tested and 7 of them accepted this test.

★ ★ ★

THE results of this work were disappointing. The overwhelming proportion of welds that failed in wire drawing was sufficient evidence to realize that pressure welding was not satisfactory. Pressure welds of .65% and .80% carbon steel would not wire draw consistently, much less accept the wrap test. The expected advantages of pressure welding did not materialize.

★ ★ ★

THE last portion of this paper deals with the problem of welding finished rope wire prior to the spooling and stranding operations in making wire rope. A satisfactory weld must withstand bending back and forth several times over the finger to indicate the soundness of the weld as well as relative ductility.

★ ★ ★

MICROSCOPIC examination of a number of welds which failed in this test indicated an insufficient anneal in each instance. By insufficient anneal is meant that the weld was not heated above the critical temperature. The weld zone structure was generally a tempered martensite, as shown in Fig. 17, with a sharp line of demarkation between the wire drawn section and the zone heated in welding. It was difficult to believe that insufficient anneal was the source of trouble, as a casual observation of the annealing operation indicated that the entire section between the annealing jaws was heated to the proper annealing temperature. Closer observation indicated that the wire on either side of the weld was heated to the annealing temperature while the weld lagged behind. In fact, the weld zone was often black in color. The annealing occurs so quickly that only a very close observation could detect this variation in temperature along the length of the wire between the annealing jaws.

★ ★ ★

A BEND test was employed to prove the effect of insufficient annealing. Welds were made in .040" diameter improved plow rope wire on a Micro E1S Welder and annealed in two ways: one was a regular anneal as generally practiced in the Shop; the other was a slow anneal in which the entire section between the annealing jaws was heated uniformly above the upper critical temperature. The upsets were filed off until no upset was visible. The stock wire was

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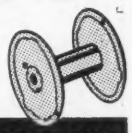

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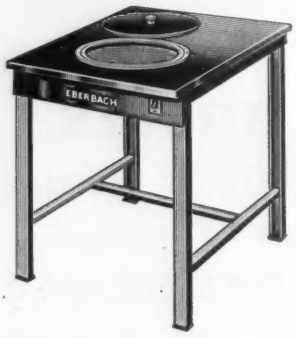

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also filed. The bend tests were performed over a mandrel ten times the wire diameter and the results are shown in Table IV.

TABLE IV
NUMBER OF 90° BENDS ON 10 DIAMETERS

Sample No.	Stock Wire	Usual Anneal	Uniform High Temperature Anneal
1	35	6	39
2	34	12	24
3	25	17	19
4	32	(36)	29
5	32	(32)	38
6		(31)	29
7		12	35
8		17	32
9		13	33
10		18	35
Average	32	19 (13)	30

THE test results for the usual anneal show low and variable ductility. The three samples with the high bend values, in parenthesis, apparently had been satisfactorily annealed. If these three samples are eliminated, the average is 13 bends, or an efficiency of about 40% of the stock wire. The bend test efficiency of the welds annealed at a high temperature was 93% in comparison.

★ ★ ★

APPARENTLY the annealing practice should be changed to anneal the welds at a considerably higher temperature. In order to do this annealing job properly it was felt that an automatic device was required which would take the decision out of the operator's hands and insure a uniformly annealed weld each time. Such a welder was designed and is shown in Fig. 18. Actually it is a welding head adapted to a Micro Products Company's E1S welding transformer. The welding head is composed of a housing which contains a shaft on which are 10 cams. These operate the welding and annealing jaws on the face of the welder. The cams also operate micro switches which control the electrical sequence of the operation. The cam shaft is driven through a gear reducing system by a small electric motor. Of the four jaws on the face of the welder, the two middle ones are the welding jaws; the two outside ones are

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the annealing jaws. The left-hand welding and annealing jaws act as a unit in that they pivot together as a carriage moves to consumate a weld.

★ ★ ★

THE total time to complete the cycle is 30 seconds and the welding range of wire sizes is .010″ to .040″ diameter.

★ ★ ★

THE operator inserts the wires between the welding and annealing jaws. The starting button is pushed, after which the welding cycle proceeds automatically. After the weld is made, the welding jaws open and the annealing jaws, which now hold the wire, move so as to raise the wire to clear the welding jaws. The annealing current is applied for a set time sufficient to anneal the wire and the weld. The annealing current is shut off and the wire is held until recalescence occurs. The annealing jaws then open, the wire falls out and the jaws return to the starting position.

★ ★ ★

USE of this machine in welding has reduced weld failures to a minimum. The uniform and controlled annealing has overcome the problem of insufficient annealing and results in a uniformity of welding heretofore unobtainable.

★ ★ ★

THIS paper has described efforts to make welds of a quality high enough to be left in finished wire. Both methods which were tried were unsatisfactory. The problem has yet to be solved and a solution may lie in resistance butt welding.

★ ★ ★

THE automatic and controlled welding device has been a means for making uniform welds in finished hard drawn rope wire.

★ ★ ★

Acknowledgments

The author wishes to express his appreciation to the John A. Roebling's Sons Company for permission to publish this paper; to Messrs. H. M. Gruner, E. E. Richardson and G. R. Hulick for the experimental work and data, to the various wire producers and consumers who contributed information.

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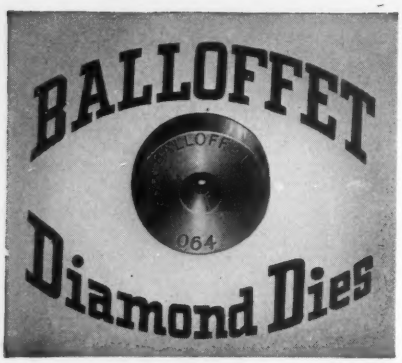

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General Electric Publishes Report on Silicone Oils

"GENERAL Electric Silicone Oils," a technical report describing physical properties of all nine G-E silicone liquids has been issued by the Company's Chemical Department as an aid in the selection of the proper material for mold release agents, damping media, motor lubricants, anometer liquids, and other applications requiring fluids with low flow points, high temperature stability, and minimum viscosity changes.

★ ★ ★

THE report describes G-E silicone oils as water white liquids, insert in contact with common metals, and having excellent electrical properties. Included in the publication is a viscosity-temperature chart for each grade, as well as complete data on expansion coefficients, refraction indices, specific gravities, and other physical properties.

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(*Continued from page 907*)

man and directors of Messrs. Rylands Brothers, Ltd., and the Whitecross Co., Ltd., Warrington, for permission to publish this paper. Thanks are also due to Lt. Com. G. K. Rylands for his great interest and counsel during the course of the work, and to Mr. Bernard Ryan for carrying out a number of the tests with great skill and patience.

★ ★ ★

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Republic Steel Appointments

EARL M. RICHARDS is the new vice-president in charge of planning and development at **Republic Steel Corp.**, Cleveland, having previously been vice-president in charge of operations. He joined the corporation shortly after its organization as chief industrial engineer. **W. M. Kelley** has been elected to succeed Earl M. Richards as vice-president in charge of operations at **Republic Steel Corp.** Mr. Kelley has for the past four years directed the manufacturing divisions of the corporation. He joined Republic in 1936 as works manager of the Truscon Steel Co. **Peter Robertson** has become assistant vice-president in charge of operations in the manufacturing divisions of **Republic Steel Corp.**, Cleveland. He was formerly works manager of the Truscon Steel Co., a Republic subsidiary.

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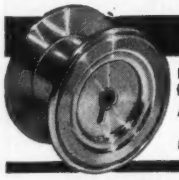
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Ross, J. O., Engineering Corp. 975
Royle, John & Sons 832
Ruesch, H. J., Machine Co. 992
Rusch Wire Die Corporation 991
Sauereisen Cements Company 992
Schuyler, W. A. 977
Scott Testers, Inc. 973
Scudder, E. J. Foundry & Machine Co. 992
Sjogren Tool and Machine Co., Inc. 936B
Sleeper & Hartley, Inc. 992
Standard Industrial Compounds Co. 813
Standard Machinery Co., The 840
Standard Mill Supply Co. 972
Steel Equipment Co. 834
Surface Combustion Corp. 843
Swift & Company 837
Syncro Machine Company ..... 912 & 913
Tennessee Coal, Iron & R.R. Co. ..... 829 & 853
Terkelsen Machine Company 992
Torrington Mfg. Co. 992
Trauwood Engineering Co., The 845
Twitchell, E. W., Inc. 849
U. S. Steel Export Company ..... 829 & 853
Vascoloy-Ramet Corporation 854
Vaughn Machinery Co. ..... Front Cover & 872 A, B, C, D
Vianney Wire Die Works 990
Wardwell Braiding Machine Co. 946
Warner Company 989
Waterbury Farrel Foundry & Machine Co. ..... 817 & 856
Watson Machine Company ..... Inside Back Cover
Wayne Wire Die Co. 990
Wean Equipment Corporation ..... Inside Front Cover
Wickman, A. C., Ltd. 939
Wickwire Brothers, Inc. 986
Wickwire Spencer Steel Div. Colorado Fuel & Iron Corp. 836
Wickwire, T. H., Jr. 993
Willey's Carbide Tool Co. 962
Williams, A. R. Machy. Co., Ltd. 985
Wilson, Lee, Engineering Co., Inc. 809
Wire & Textile Machinery, Inc. 986
Youngstown Sheet & Tube Company, The 815
Youngstown Welding & Engineering Company, The 974

WHERE TO BUY

For more complete information, consult the annual Wire and Wire Products Directory, Index & Buyer's Guide.

ABRASIVES—
Norton Co., Worcester, Mass.

ACID INHIBITORS—
(See Inhibitors, Pickling)

ACID-PROOF CONSTRUCTION
Atlas Mineral Products Co., Mertztown, Pa.
Chemsteel Construction Co., Pittsburgh, Pa.
Haveg Corporation, Newark, Del.
Sauereisen Cements Co., Pittsburgh, Pa.

ANNEALING MACHINES—Open Flame
Syncro Machine Co., Perth Amboy, N J.

ANNEALING POTS AND BOXES—
National Annealing Box Co., Washington, Penna.
Scudder, E. J., Foundry & Machine Co., Trenton, N. J.

ARMORING EQUIPMENT—
American Insulating Mach'y. Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machy., Inc., Pawtucket, R. I.

BAKERS—Rod and Wire
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Morgan Construction Co., Worcester, Mass.
Ross, J. O., Engr. Corp., New York, N. Y.

BAR STOCK—Stainless Steel
Armco Steel Corp., The, Middletown, Ohio.
American Steel & Wire Company, Cleveland Chicago, New York.
Columbia Steel Co., San Francisco, Calif
U. S. Steel Export Company, New York, N. Y.

BOBBINS—Braider & Wire Weaving
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

BORAX—Wire Drawing
Pacific Coast Borax Corp., New York, N. Y.

BORON CARBIDE—
Norton Co., Worcester, Mass.

BRAKES—Pneumatic
Entwistle, Jas. L. Co., Pawtucket, R. I.

CABLE LACQUERING OVENS—
Industrial Ovens, Inc., Cleveland, O.

CARRIERS—Braider, High Speed
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Williams, A. R., Machy. Co., Ltd., Toronto, Canada.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

CASTINGS—Wire Mill
Scudder, E. J., Fdry. & Mach. Co., Trenton, N.J.

CEMENTS—Acid Proof
Atlas Mineral Products Co., Mertztown, Pa.
Sauereisen Cements Co., Pittsburgh, Pa.

CEMENTS—Refractory
Norton Co., Worcester, Mass.
Sauereisen Cements Co., Pittsburgh, Pa.

CHEMICALS—Cleaning
(See Cleaners—Metal)

CLEANERS—Metal
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Phila., Pa.
Magnus Chemical Co., Garwood, N. J.
Magnuson Products Corp., Brooklyn, N. Y.
Metal & Thermit Corp., New York, N. Y.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

CLEANING & PICKLING EQUIP.—
Chemsteel Construction Co., Pittsburgh, Pa.
Cleveland Tramrail Div., of the Cleveland Crane & Engineering Co., Wickliffe, O.
Haveg Corp., Newark, Del.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

CLOTH—WIRE, All Metals
Roebling's, John A. Sons, Co., Trenton, N. J.
Wickwire Bros., Cortland, N. Y.
Wickwire Spencer Steel Division, Colorado Fuel & Iron Corp., Buffalo, N. Y.

COATING COMPOUNDS—
Apex Alkali Products Co., Philadelphia, Pa.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

COILERS—Sheet, Strip and Wire
Entwistle, Jas. L. Co., Pawtucket, R. I.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J. Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Corp., Cleveland, Ohio.

COLD HEADERS—
Ajax Manufacturing Co., Cleveland, Ohio.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.

COMPOUNDS—Coppering
American Chemical Paint Co., Ambler, Pa.

COMPOUNDS—Diamond
Eastern Carbide Corp., New Rochelle, N. Y.
Hyprez Division, Engis Equipment Co., Chicago, Ill.
Magnus Chemical Co., Garwood, N. J.

COMPOUNDS—Metal Finishing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Metal & Thermit Corp., New York, N. Y.

COMPOUNDS—Rust Preventing
American Chemical Paint Co., Ambler, Pa.
American Lanolin Corp., Lawrence, Mass.
Apex Alkali Products Co., Philadelphia, Pa.
Fiske Bros. Refining Co., Newark, N. J.
Magnus Chemical Co., Garwood, N. J.
Oakite Products, Inc., New York, N. Y.

COMPOUNDS—Rust Removing
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

COMPOUNDS—Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Fiske Bros. Refining Co., Newark, N. J.
Magnus Chemical Co., Garwood, N. J.
Magnuson Products Corporation, Brooklyn, N. Y.
Miller, R. H. Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Pacific Coast Borax Corp., New York, N. Y.
Potter, Neil C., Newark, N. J.
Reilly Whiteman Walton, Conshohocken, Pa.
Standard Industrial Compounds Co., Inc., Chicago, Ill.
Swift & Company, Chicago, Ill.

COPHOLDERS—Steel
Apco Mossberg Co., Attleboro, Mass.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

CRANES—Wire Mill
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.
Morgan Construction Co., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

CUTTING TOOLS—Carbide
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, New York.
Vascoloy-Ramet Corp., North Chicago, Ill.
Willey's Carbide Tool Co., Detroit, Mich.

CUTTING TOOLS—Wire
Porter, H. K., Inc., Everett, Mass.

DIAMONDS—Industrial
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Champion Diamond Co., New York, N. Y.
Diamond Distributors, Inc., New York, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND POWDERS—
Champion Diamond Co., New York, N. Y.
Diamond Distributors, Inc., New York, N. Y.
Eastern Carbide Corp., New Rochelle, N. Y.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Hyprez Division, Engis Equipment Co., Chicago, Ill.
Indiana Wire Die Co., Ft. Wayne, Ind.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIAMOND TOOLS—
Carboloy Co., Inc., Detroit, Mich.
Champion Diamond Co., New York, N. Y.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Carbide
(See Dies—Tungsten Carbide)

DIES—Cold Heading
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Indiana Wire Die Co., Ft. Wayne, Ind.
Metal Carbides Corporation, Youngstown, Ohio.
Vascoloy-Ramet Corp., No. Chicago, Ill.

DIES—Diamond
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Champion Diamond Co., New York, N. Y.
Cochaud Wire Die Corp., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.

DIES—Extrusion
Adamas, Carbide Corporation, Harrison, N. J.
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Metal Carbides Corporation, Youngstown, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Eyelet
Kelly Wire Die Corp., New York, N. Y.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.

DIES—Pointing
Sjogren Tool and Machine Co., Auburn, Mass.

DIES—Repairs & Re-Cutting
Adamas, Carbide Corporation, Harrison, N. J.
Ajax Industrial Supplies, Inc., Fort Wayne, Ind.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Detroit, Mich.
Champion Diamond Co., New York, N. Y.
Cochaud Wire Die Corp., New York, N. Y.
Ft. Wayne Wire Die, Inc., Fort Wayne, Ind.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.

WHERE TO BUY, Continued

Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
New England Wire Die Co., Worcester, Mass.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DIES—Special Shapes, Etc.

Adamas, Carbide Corporation, Harrison, N. J.
Eastern Carbide Corp., New Rochelle, N. Y.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Indiana Wire Die Co., Fort Wayne, Ind.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.

DIES—Swaging

Fenn Manufacturing Co., Hartford, Conn.

DIES—Tantalum Carbide

Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.

DIES—Tube Drawing

Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Indiana Wire Die Co., Fort Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, O.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Willey's Carbide Tool Co., Detroit, Mich.
Williams, A. R., Machy. Co., Ltd. Toronto, Canada.

DIES—Tungsten Carbide

Adamas, Carbide Corporation, Harrison, N. J.
Balloffet Dies & Nozzle Co., Inc., Guttenberg, N. J.
Carboloy Co., Inc., Detroit, Mich.
Eastern Carbide Corp., New Rochelle, N. Y.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Hoosier Wire Die, Inc., Ft. Wayne, Ind.
Kelly Wire Die Corp., New York, N. Y.
Metal Carbides Corp., Youngstown, Ohio.
Rusch Wire Die Corp., Croton-on-the-Hudson, N. Y.
Vascoloy-Ramet Corp., North Chicago, Ill.
Vianney Wire Die Wks., New York, N. Y.
Wayne Wire Die Co., Hillside, N. J.
Willey's Carbide Tool Co., Detroit, Mich.

DRAW BENCHES—

(See MACHINERY—Draw Benches)

DRUMS—Flange Steel

Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.

DRUMS—Vulcanizing

Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., The, Paterson, N. J.

DRYING EQUIPMENT—

Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engineering Corp., New York, N. Y.

ENGINEERS—Consulting Hot Galvanizing

Wallace G. Imhoff Co., The, Los Angeles, Calif.

ENGINEERS—Consulting Spring Design

Carlson, Co., The, New York, N.Y.

ENGINEERS—Consulting Wire Mill

Fisher, Edward J. P., North Jackson, Ohio.
Lewis, Kenneth B., Worcester, Mass.
Wickwire, T. H. Jr., Philadelphia, Pa.

EQUIPMENT—Insulation Testing

Davis, R. L., Elec. Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Williams, A. R., Machy. Co., Ltd. Toronto, Canada.

EYELETS—Brass or Zinc

Platt Bros. & Co., The, Waterbury, Conn.

FLUXES—Soldering

American Chemical Paint Co., Ambler, Pa.

FOAM PRODUCING COMPOUNDS—

American Chemical Paint Co., Ambler, Pa.
Parkin, Wm. M. Co., Pittsburgh, Pa.

FRICTION PAY-OFF STANDS—

Industrial Ovens, Inc., Cleveland, Ohio.

FURNACES—Annealing

Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Automatic

Carl-Mayer Corp., The, Cleveland, Ohio
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Brazing

Electric Furnace Co., Salem, Ohio.

FURNACES—Bright Annealing

Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corp., Toledo, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Electric

Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio.

FURNACES—Galvanizing Equipment

Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engineering Co., The, Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

FURNACES—Hard'ing & Temp'ing

Ajax Electric Co. Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corp., Toledo, Ohio.
Trauwood Engr. Co., The, Cleveland, Ohio.

FURNACES—Lead Melting

Electric Furnace Co., Salem, Ohio.
Robertson, John, Co., Brooklyn, N. Y.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Non-Oxidizing

Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Normalizing

Ajax Electric Co., Inc., Philadelphia, Pa.
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corp., Toledo, Ohio.

FURNACES—Pot (Oil, Gas, Electric)

Ajax Electric Co., Inc., Philadelphia, Pa.

FURNACES—Resistance Heating, Strand

Trauwood Engineering Co., Cleveland, Ohio.

FURNACES—Salt Bath

Ajax Electric Co., Inc., Philadelphia, Pa.
Electric Furnace Co., Salem, Ohio.
Surface Combustion Corporation, Toledo, O.

FURNACES—Wire, Strip & Sheet

Carl-Mayer Corp., The, Cleveland, Ohio.
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio.
Harper Electric Furnace Corp., Niagara Falls, N. Y.
Surface Combustion Corporation, Toledo, O.
Trauwood Engineering Co., The, Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

GALVANIZING EQUIPMENT—

Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

GALVANIZING KETTLES—

National Annealing Box Co., Washington, Penna.

GRINDERS—Roll

Norton Co., The, Worcester, Mass.

HAMMERS—Swaging

Sjogren Tool and Machine Co., Auburn, Mass.

HOISTS—Electric Travelling

Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, Ohio.

HOOKS—Pickling and Liming

Gordon, Clark E., Detroit, Mich.
Youngstown Welding & Engineering Co., Youngstown, Ohio.

INHIBITORS—Pickling

American Chemical Paint Co., Ambler, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

INSULATING LACQUERING SYSTEMS—Continuous

American Insulating Machine Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.

INSULATING MATERIALS—

Belding, Heminway, Corticelli Co., New York, N. Y.
Du Pont de Nemours, E. I., Co., Wilmington, Del.
Martin, Glenn L., Company, Baltimore, Md.
Merrimac Paper Co., New York, N. Y.
Owens Corning Fiberglas Corp., Toledo, O.
Twitchell, E. W., Philadelphia, Pa.

INSULATING MATERIALS—Paper—For Electric Wire Cable.

Merrimac Paper Co., New York, N. Y.
Twitchell, E. W., Philadelphia, Pa.

LATHES—Die Reaming

Carboloy Co., Inc., Detroit, Mich.
Roos, Tool & Mfg. Co., Montclair, N. J.

LIME—

Warner Co., Philadelphia and Bellefonte, Pa.

LININGS—Acid and Alkali Proof

Haveg Corp., Newark, Del.
Sauereisen Cements Co., Pittsburgh, Pa.

LUBRICANTS—Machinery

Fiske Bros. Refining Co., Newark, N. J.

LUBRICANTS—For Metal Cutting, Stamping and Drawing

Apex Alkali Products Co., Philadelphia, Pa.
Fiske Bros. Refining Co., Newark, N. J.
Ironsides Co., The, Columbus, Ohio.
Magnus Chemical Co., Garwood, N. J.

WHERE TO BUY, Continued

Miller, R. H., Co., Inc., Homer, N. Y.
Oakite Products, Inc., New York, N. Y.
Reilly Whiteman Walton, Conshohocken, Pa.
Standard Industrial Compounds Co., Inc., Chicago, Ill.

LUBRICANTS—Wire Drawing
(See Compounds—Wire Drawing)

LUBRICANTS—Wire Rope
Fiske Bros. Refining Co., Newark, N. J.
Swift & Co., Chicago, Ill.

LUMBER—Wire Mill, for lagging and car blocking.
North Anson Reel Co., North Anson, Maine

MACHINERY—Armoring (Cable, Wire Hose)
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Bar Continuous
Schuyler, W. A., New York, N. Y.

MACHINERY—Barbed Wire
Glader Machine Works, Chicago, Ill.
Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Wean Engineering Co., Cleveland, Ohio.

MACHINERY—Bead Wrapping
Terkelsen Machine Co., Boston, Mass.

MACHINERY—Braiding
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Wardwell Braiding Machine Co., Central Falls, R. I.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Brazing
Eisler Engineering Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Bunching
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Bundling, Scrap
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Cable, Electric
American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Chain Making
Nilson, A. H. Machine Co., The, Bridgeport, Conn.

MACHINERY—Cable, Rope Closing
New England Butt Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Coilers
Boyd & Sons Manufacturing Co., Phila., Pa.
Eisler Engineering Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
National Machinery Exchange (used), New York, N. Y.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Williams, A. R., Machy Co., Ltd., Toronto, Canada.
Wire & Textile Machinery, Inc., Pawtucket, R. I.

MACHINERY—Cold Heading
(See Cold Headers)

MACHINERY—Copper Wire Drawing and Rolling
Aetna-Standard Engineering Co., Youngstown, Ohio.
American Insulating Mach'y Co., Phila., Pa.
Fenn Manufacturing Co., Hartford, Conn.
National Machinery Exchange (used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Fdry. & Mach. Co., Waterbury, Conn.

MACHINERY—Covering Wire
American Insulating Mach'y Co., Phila., Pa.
National Erie Corp., Erie, Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Syncro Machine Co., Perth Amboy, N. J.
Wardwell Braiding Machine Co., Central Falls, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Cutting
Eisler Engineering Co., Newark, N. J.
Hallden Machine Co., The, Thomaston, Conn.
Lewis Machine Co., The, Cleveland, Ohio.
Mettler Machine Tool, Inc., New Haven, Conn.
National Mach'y Exch. (Used) New York, N. Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
Porter, H. K., Inc., Everett, Mass.
Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Die Making
Carboloy Co., Inc., Detroit, Mich.
Firth Sterling Steel & Carbide Corp., McKeesport, Pa.
Kelly Wire Die Corp., New York, N. Y.
Roos, Tool & Mfg. Co., Montclair, N. J.
Wayne Wire Die Co., Hillside, N. J.
Wickman, A. C., Ltd. Coventry, England.

MACHINERY—Draw Benches
Aetna-Standard Engineering Co., Youngstown, Ohio.
Ajax Manufacturing Co., Cleveland, Ohio.
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Edging
Fenn Manufacturing Co., Hartford, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Enameling
American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Extruding
National Erie Co., Erie, Pa.
Robertson, John, Co., Brooklyn, N. Y.
Royle, John, & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Fence
Blashill, Arthur, Woodstock, Ont., Canada.
Glader, Wm., Machine Works, Chicago, Ill.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Filament Coil Winding
Eisler Engineering Co., Newark, N. J.

MACHINERY—Flat Wire
Fenn Manufacturing Co., Hartford, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Galvanizing
(See Galvanizing Equipment)

MACHINERY—Galvanizing Wire
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.
Wilson, Lee, Engr. Co., Cleveland, Ohio.

MACHINERY—Gang Winders
Entwistle, Jas. L. Co., Pawtucket, R. I.
Ruesch, H. J., Machine Co., Newark, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Grinding
Norton Co., The, Worcester, Mass.
Schuyler, W. A., New York, N. Y.

MACHINERY—Grinding Centerless
Schuyler, W. A., New York, N. Y.

MACHINERY—Insulating
American Insulating Mach'y Co., Phila., Pa.
National Erie Co., Erie, Pa.
New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Lead Encasing Presses, etc.
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lead Stripping
Robertson, John Co., Brooklyn, N. Y.

MACHINERY—Lock Washer
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Looms, Wire Weaving
Bruckner-Mitchell, Inc., New York, N. Y.

MACHINERY—Magnet Wire
American Insulating Mach'y Co., Phila., Pa.
Fenn Manufacturing Co., Hartford, Conn.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Material Handling
Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MACHINERY—Measuring Wire & Cable
Durant Mfg. Co., Milwaukee, Wis.
Entwistle, Jas. L. Co., Pawtucket, R.I.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Nail and Tack
Glader, Wm., Machine Works, Chicago, Ill.
National Mach'y Exch. (Used), New York, N.Y.
Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Panning
American Insulating Mach'y Co., Phila., Pa.
Syncro Machine Co., Perth Amboy, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I

MACHINERY—Pickling
Chemsteel Construction Co., Pittsburgh, Pa.
Gordon, Clark E., Detroit, Mich.
Youngstown Welding & Engineering Company, Youngstown, Ohio.

MACHINERY—Pointing
Aetna-Standard Engineering Co., Youngstown, Ohio.
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rod Mill
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
Ruesch, H. J., Machine Co., Newark, N. J.
Schuyler, W. A., New York, N. Y.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rolling Mill
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N.Y.
Ruesch, H. J., Machine Co., Newark, N. J.

WHERE TO BUY, Continued

Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.
Waterbury-Farrel Foundry & Machine Co., Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Rubber Insulating

Royle, John & Sons, Paterson, N. J.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Rubber Tubing and Straining

New England Butt Co., Providence, R. I.
Royle, John & Sons, Paterson, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Machinery Co., Mystic, Conn.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Screw Wire

National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Special

American Insulating Mach'y Co., Phila, Pa.
Bruckner-Mitchell, Inc., New York, N. Y.
Davis, R. L. Electric Co., Wallingford, Conn.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
Fenn Manufacturing Co., Hartford, Conn.
New England Butt Co., Providence, R. I.
Ruesch, H. J. Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Spooling

American Insulating Mach'y Co., Phila., Pa.
Boyd & Sons Manufacturing Co., Phila., Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Eisler Engineering Co., Newark, N. J.
Emory, Robert J., Co., Newark, N. J.
Entwistle, Jas. L. Co., Pawtucket, R. I.
National Mach'y Exch. (Used), New York, N.Y.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply Co., Pawtucket, R. I.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury, Conn.
Watson Machine Co., Paterson, N. J.
Wean Equipment Corp., Cleveland, Ohio.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

MACHINERY—Spring Making

National Mach'y Exch. (Used), New York, N.Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Staple

Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.

MACHINERY—Steel Bate Ties

Reed & Richards Transatlantic Co., Inc., New York, N. Y.

MACHINERY—Straightening

Ajax Manufacturing Co., Cleveland, Ohio.
Hallden Machine Co., Thomaston, Conn.
Lewis Machine Co., The, Cleveland, Ohio.
Mettler Machine Tool Co., New Haven, Conn.
National Mach'y Exch. (Used), New York, N.Y.
Nilson, A. H. Machine Co., Bridgeport, Conn.
Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Stranding

Hughesville Machine & Tool Co., Hughesville, Pa.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Providence, R. I.
Watson Machine Co., Paterson, N. J.

MACHINERY—Strip Forming

Wickman, A. C., Ltd., Coventry, England.

MACHINERY—Strip Steel

Aetna-Standard Engineering Co., Youngstown, Ohio.
Fenn Manufacturing Co., Hartford, Conn.
Ruesch, H. J., Machine Co., Newark, N. J.
Steel Equipment Co., Cleveland, Ohio.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Swaging

Fenn Manufacturing Co., Hartford, Conn.
National Erie Corp., Erie, Pa.
National Mach'y Exch. (Used), New York, N.Y
Ruesch, H. J., Machine Co., Newark, N. J.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Waterbury-Farrel Foundry & Machine Co. Waterbury, Conn.

MACHINERY—Taping

American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.
Wire & Textile Machinery, Inc., Pawtucket, R.I.

MACHINERY—Testing Physical

Eberbach & Son Co., Ann Arbor, Mich.
Scott Testers, Inc., Providence, R. I.

MACHINERY—Testing Equipment—Sparkers

Davis, R. L. Elec. Co., Wallingford, Conn.
Entwistle, Jas. L., Pawtucket, R. I.
Wire & Textile Machinery, Inc., Pawtucket, R.I

MACHINERY—Tinning Wire

American Insulating Mach'y Co., Phila., Pa.
New England Butt Co., Providence, R. I.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Wean Equipment Co., Cleveland, Ohio.

MACHINERY—Tinsel Rolling Mills

American Insulating Mach'y Co., Phila., Pa.
Fenn Manufacturing Co., Hartford, Conn.
Syncro Machine Co., Perth Amboy, N. J.
Torrington Mfg. Co., Torrington, Conn.

MACHINERY—Trolley Wire

Torrington Mfg. Co., Torrington, Conn.
Vaughn Machinery Co., Cuyahoga Falls, O.

MACHINERY—Welding Wire

Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago, Ill.
Syncro Machine Co., Perth Amboy, N. J.

MACHINERY—Winding

American Insulating Mach'y Co., Phila., Pa.
Davis, R. L. Electric Co., Wallingford, Conn.
Eisler Engineering Co., Newark, N. J.
New England Butt Co., Providence, R. I.
Sleeper & Hartley, Inc., Worcester, Mass.
Standard Mill Supply, Pawtucket, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wind-up (Constant Tension, Variable Speed)

Aetna-Standard Engineering Co., Youngstown, Ohio.
Davis, R. L. Electric Co., Wallingford, Conn.
Fenn Manufacturing Co., Hartford, Conn.
Industrial Ovens, Inc., Cleveland, Ohio.
Standard Machinery Co., Mystic, Conn.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wire Bending

Eisler Engineering Co., Newark, N. J.
Kilmer, M. D., & Co., Cleveland, Ohio.

MACHINERY—Wire Drawing

Aetna-Standard Engineering Co., Youngstown, Ohio.
Ajax Manufacturing Co., Cleveland, Ohio.
American Insulating Mach'y Co., Phila., Pa.
Fenn Manufacturing Co., Hartford, Conn.
Morgan Construction Co., Worcester, Mass.
National Mach'y Exch. (Used), New York, N. Y.
Ruesch, H. J., Machine Co., Newark, N. J.
Scudder, E. J., Fdry & Mach. Co., Trenton, N.J.
Sleeper & Hartley, Inc., Worcester, Mass.
Steel Equipment Co., Cleveland, Ohio.
Syncro Machine Co., Perth Amboy, N. J.
Vaughn Machinery Co., Cuyahoga Falls, O.
Waterbury-Farrel Foundry & Machine Co. Waterbury, Conn.
Wean Equipment Corp., Cleveland, Ohio.

MACHINERY—Wire Forming

Fenn Manufacturing Co., Hartford, Conn.
Kilmer, M. D. & Co., Cleveland, Ohio.
National Mach'y Exch. (Used), New York, N.Y.
Nilson Machine Co., A. H., Bridgeport, Conn.
Reed & Richards Transatlantic Co., Inc., New York, N. Y.
Sleeper & Hartley, Inc., Worcester, Mass.
Wickman, A. C., Ltd., Coventry, England.

MACHINERY—Wire Rope

New England Butt Co., Providence, R. I.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

MACHINERY—Wood Screw

National Mach'y Exch. (Used), New York, N.Y.

MACHINERY—Wrapping Straight Lengths and Tubing

Terkelsen Machine Co., Boston, Mass.

MACHINERY—Wrapping Wire Coils

Terkelsen Machine Co., Boston, Mass.

MATERIAL HANDLING EQUIPMENT

Cleveland Tramrail Div. of The Cleveland Crane & Engineering Co., Wickliffe, O.

MILLS—Tandem, Rolling & Edging

Torrington Mfg. Co., Torrington, Conn.
Wean Equipment Co., Cleveland, Ohio.

NAIL DIE GRINDERS

Reed & Richards Transatlantic Co., Inc., New York, N. Y.

NAILS—Wire

American Steel & Wire Co., Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Portsmouth Steel Corp. Portsmouth, Ohio.
Roebling, John A. Sons Co., Trenton, N. J.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
U. S. Steel Export Co., New York, N. Y.

NICKEL SILVER AND PHOSPHOR BRONZE—Rod, Wire and Strip

Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.

OVENS—Cable Lacquering

American Insulating Mach'y Co., Phila., Pa.
Industrial Ovens, Inc., Cleveland, Ohio.

OVENS—Dehydrogenizing

Carl-Mayer Corp., The, Cleveland, Ohio.
Industrial Ovens, Inc., Cleveland, Ohio.

OVENS—Industrial

Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

OVENS—Welding Rod Coating

Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Industrial Ovens, Inc., Cleveland, Ohio.
Ross, J. O., Engr. Corp., New York, N. Y.

PAINTS—Heat Resisting

American Chemical Paint Co., Ambler, Pa.

PANS—Lead and Spelter

National Annealing Box Co., Washington, Pa.

PANS—Vulcanizing

Mossberg Pressed Steel Corp., Attleboro, Mass.

PAPER—Creped Wrapping

Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.
Terkelsen Machine Co., Boston, Mass.

PAPER—For Coil Wrapping and Corrosion Prevention

Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.
Terkelsen Machine Co., Boston, Mass.

WHERE TO BUY, Continued

PATENT ATTORNEYS—
Lancaster, Allwine & Rommel, Washington, D.C.

PICKLING COMPOUNDS—
American Chemical Paint Co., Ambler, Pa.
Apex Alkali Products Co., Philadelphia, Pa.
Oakite Products, Inc., New York, N. Y.
Parkin, Wm. M., Co., Pittsburgh, Pa.

PICKLING—Hooks, etc. Acid Resisting
Gordon, Clark E., Detroit, Mich.
Youngstown Welding & Engineering Company, Youngstown, Ohio.

PICKLING TANK LININGS—
Atlas Mineral Products Co., Mertztown, Pa.
Chemsteel Construction Co., Pittsburgh, Pa.
Haveg Corp., Newark, Del.
Sauereisen Cements Co., Pittsburgh, Pa.

PIPES & FITTINGS—Acid Resistant
Chemsteel Construction Co., Pittsburgh, Pa.
Haveg Corp., Newark, Del.
Knight, Maurice Co., Akron, Ohio.

PLASTIC TESTERS—
Scott Testers, Inc., Providence, R. I.

PLATING PROCESS—Electrolytic
Kenmore Metals Corp., Jersey City, N. J.

PNEUMATIC CYLINDERS
Entwistle, James L. Co., Pawtucket, R. I.

POTS—Lacquer
Industrial Ovens, Inc., Cleveland, Ohio.

POTS—Lead Melting
National Annealing Box Co., Washington, Pa.
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Hydraulic and Mechanical
Robertson, John, Co., Brooklyn, N. Y.

PRESSES—Lead
Robertson, John, Co., Brooklyn, N. Y.

PRESSURE VESSELS—
National Annealing Box Co., Washington, Pa.

PULLERS AND GRIPS—For Wire
Morgan Construction Co., Worcester, Mass.
Scudder, E. J. Fdry & Mach. Co., Trenton, N.J.
Sjogren Tool and Machine Co., Auburn, Mass.
Sleeper & Hartley, Inc., Worcester, Mass.
Vaughn Machinery Co., Cuyahoga Falls, O.
Wean Equipment Corp., Cleveland, Ohio.

PUMPS—Hydraulic
Robertson, John, Co., Brooklyn, N. Y.

REEL AND TENSION STANDS—
Davis, R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Roll-a-Reel, Cincinnati, Ohio.
Sleeper & Hartley, Inc., Worcester, Mass.
Syncro Machine Co., Perth Amboy, N. J.
Watson Machine Co., Paterson, N. J.

REEL CRUTCHES—
Roll-a-Reel, Cincinnati, Ohio.
Watson Machine Co., Paterson, N. J.

REELS & SPOOLS—Drawn Aluminum Alloy
Acrometal Products, Inc., Minneapolis, Minn.
Hubbard Spool Co., Chicago, Ill.

REELS & SPOOLS—Annealing and Stranding
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS & SPOOLS—Collapsible
Entwistle, Jas. L. Co., Pawtucket, R. I.

REELS & SPOOLS—Plastic
Hubbard Spool Company, Chicago, Ill.

REELS & SPOOLS—Steel
Apco Mossberg Co., Attleboro, Mass.
Clark, J. L., Mfg. Co., Rockford, Ill.
Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS AND SPOOLS—Shipping and Shop
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Clark, J. L., Mfg., Co., Rockford, Ill.
Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REELS & SPOOLS—Wooden
Acrometal Products, Inc., Minneapolis, Minn.
American Woodworking Co., Chicago, Ill.
Bridge Mfg. Co., Inc., The, Hazardville, Conn.
Durkee Mfg. Co., Pine River, Minn.
Nelson Co., The, Baltimore, Md.
North Anson Reel Co, North Anson, Maine.
North Waterford Spool Co., North Waterford, Maine.

REELS—Metal Bound
Durkee Mfg. Co., Pine River, Minn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Co., Chicago, Ill.
North Anson Reel Co., North Anson, Maine.

REELS—Takeoff
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Clark, J. L., Mfg. Co., Rockford, Ill.
Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REELS—Vulcanizing & Impregnating
Apco Mossberg Co., Attleboro, Mass.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Wire Drawing
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Concord Products Co., Chicago, Ill.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

REELS—Wire Mill
Acrometal Products, Inc., Minneapolis, Minn.
Apco Mossberg Co., Attleboro, Mass.
Bridge Mfg., Co., The, Hazardville, Conn.
Concord Products Co., Chicago, Ill.
Durkee Mfg. Co., Pine River, Minn.
Howsam Spool Co., Aurora, Ill.
Hubbard Spool Company, Chicago, Ill.
Mason Can Company, Providence, R. I.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
North Anson Reel Co., North Anson, Maine.

REFRACTORIES—High Temperature
Norton Company, Worcester, Mass.

RESISTANCE HEATING—Annealing, Patenting, Etc.
Trauwood Engr. Co., Cleveland, Ohio.

ROD BAKERS—
Carl-Mayer Corp., The, Cleveland, Ohio.
Drying Systems, Inc., Chicago, Ill.
Ross, J. O., Engineering Corp., New York, N. Y.

RODS—Nickel Alloy
Eastwood Nealley Corp. Belleville, N. J.
International Nickel Co., Inc., New York, N.Y.

RODS—Stainless Steel
American Steel & Wire Co., Cleveland, Ohio.
Armco Steel Corp., The, Middletown, Ohio.

RODS—Steel, Electrolytically Coated
Kenmore Metals Corp., Jersey City, N. J.

RODS—Wire—Non-Ferrous
American Brass Co., The, Waterbury, Conn.
Anaconda Wire & Cable Corp., New York, N.Y.
Eastwood Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
Platt Bros. & Co., The, Waterbury, Conn.
Reynolds Metals Company, Louisville, Ky.

RODS—Wire, Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Keystone Steel & Wire Co., Peoria, Ill.
Portsmouth Steel Corporation, Portsmouth, O.
Roebling's John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

ROPE—Wire
American Steel & Wire Company, Cleveland, Chicago, New York.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Roebling's John A., Sons Co., Trenton, N. J.
U. S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel, Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

RUBBER AND RUBBER COMPRESSION TESTERS—
Scott Testers, Inc., Providence, R. I.

RUST PROOF COMPOUNDS—
(See Compounds—Rust Preventing)

RUST REMOVING COMPOUNDS—
(See Compounds—Rust Preventing)

SATURATION SYSTEMS—
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y Inc., Pawtucket, R. I.

SOAPS—Industrial and Wire Drawing
Apex Alkali Products Co., Philadelphia, Pa.
Bick, Hans C., Inc., Reading, Pa.
Fiske Bros. Refining Co., Newark, N. J.
Magnus Chemical Co., Garwood, N. J.
Miller, R. H. Co., Inc., Homer, N. Y.
Potter, Neil C., Newark, N. J.
Standard Industrial Compounds Co., Inc., Chicago, Ill.
Swift & Company, Chicago, Ill.

SOLVENT RESIN SYSTEMS—Experimental
Industrial Ovens, Inc., Cleveland, Ohio.

SPOOLS—Wood, Small, for Retail Wire Sales
North Waterford Spool Co., North Waterford, Maine.

STAMPINGS—Steel
Hubbard Spool Company, Chicago, Ill.
Mossberg Pressed Steel Corp., Attleboro, Mass.

STRIP—Brass and Non-Ferrous
Hudson Wire Co., Ossining, N. Y.

WHERE TO BUY, Continued

STRIP—Steel
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Ind.
Laclede Steel Company, St. Louis, Mo.
Roebling's, John A., Sons Co., Trenton, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

SWIFTS—Take-off
Apco Mossberg Co., Attleboro, Mass.
Mossberg Pressed Steel Corp., Attleboro, Mass.
Watson Machine Co., Paterson, N. J.

TANKS—Compound
Atlas Mineral Products Co. of Pa., Mertztown, Pa.
Haveg Corp., Newark, Del.
Watson Machine Co., Paterson, N. J.

TANKS—Pickling
Chemsteel Construction Co., Pittsburgh, Pa.
Haveg Corp., Newark, Del.
Knight, Maurice A., Akron, Ohio.
Sauereisen Cements Co., Pittsburgh, Pa.

TANKS—Steel
Chemsteel Construction Co., Pittsburgh, Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.
National Annealing Box Co., Washington, Pa.

TINSEL—Cords, Decorative
(See: Tinsel—Electric Conductor)

TINSEL—Electric Conductor
Hudson Wire Co., Ossining, N. Y.
Montgomery Co., The, Windsor Locks, Conn.
North American Philips Co., Inc., New York, New York

TINSEL—Electric Resistance
(See: Tinsel—Electric Conductor)

TINSEL—Lame, Silver and False Gold
(See: Tinsel—Electric Conductor)

TINSEL—Thread, Silver and False Gold
(See: Tinsel—Electric Conductor)

TINSEL—Thread, Decorative
(See: Tinsel—Electric Conductor)

TOOLS—Wire Cutting
Porter, H. K., Inc., Everett, Mass.

TRAMRAIL SYSTEMS—
Cleveland Tramrail Div. of the Cleveland Crane & Engineering Co., Wickliffe, O.

TRAVERSES—For Reels
Concord Products Co., Chicago, Ill.
Entwistle, James L. Co., Pawtucket, R. I.
Hubbard Spool Company, Chicago, Ill.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.

TRAVERSE MECHANISMS—
Apco Mossberg Co., Attleboro, Mass.
Fenn Manufacturing Co., Hartford, Conn.
Mossberg Pressed Steel Corp., Attleboro, Mass.
New England Butt Co., Providence, R. I.
Niles Steel Products Div., Republic Steel Corp., Niles, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

TUBE BENDERS AND FORMERS—
H. D. Kilmer Co., Cleveland, Ohio.
Ruesch, H. J., Machine Co., Newark, N. J.

TURKS HEADS—
Fenn Manufacturing Co., Hartford, Conn.

VALVES AND FITTINGS—Acid Resistant
Haveg Corp., Newark, Del.

VULCANIZERS—
Watson Machine Co., Paterson, N. J.

VULCANIZING PANS—
American Insulating Mach'y Co., Phila., Pa.
Mossberg Pressed Steel Corp., Attleboro, Mass.

WELDERS—Spot and Butt
Eisler Engineering Co., Newark, N. J.
Micro Products Co., Chicago Ill.

WIND-UP AND UNWIND SYSTEMS—Continuous
American Insulating Mach'y Co., Phila., Pa.
Davis R. L. Electric Co., Wallingford, Conn.
Entwistle, James L., Co., Pawtucket, R. I.
Industrial Ovens, Inc., Cleveland, Ohio.
Watson Machine Co., Paterson, N. J.
Wire & Textile Mach'y, Inc., Pawtucket, R. I.

WIRE—Aluminum
Aluminum Co. of America, Pittsburgh, Pa.
Malin & Co., Cleveland, Ohio.
Reynolds Metals Company, Louisville, Ky.

WIRE—Barbed
Portsmouth Steel Corporation, Portsmouth, O.

WIRE—Bookbinding
Laclede Steel Company, St. Louis, Mo.

WIRE—Cast
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Cold Heading
American Steel & Wire Co., Cleveland-Chicago, New York.
Anaconda Wire & Cable Corp., New York, N.Y.
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Keystone Steel & Wire Co., Peoria, Ill.
Laclede Steel Company, St. Louis, Mo.
Portsmouth Steel Corporation, Portsmouth, O.
Roebling's, John A., Sons Co., Trenton, N. J.
U. S. Steel Export Co., New York, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Electric
American Brass Co., The, Waterbury, Conn.
Anaconda Wire & Cable Corp., New York, N.Y.
Hudson Wire Co., Ossining, N. Y.
Malin & Co., Cleveland, Ohio.

WIRE—Enameled for Coils
North American Philips Co., Inc., New York, New York
Winsted Div. of Hudson Wire Co., Winsted, Conn.

WIRE—Manufacturers
American Steel & Wire Co., Cleveland-Chicago, New York.
Anaconda Wire & Cable Corp., New York, N.Y.
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
Laclede Steel Company, St. Louis, Mo.
Portsmouth Steel Corporation, Portsmouth, O.
Roebling's, John A., Sons Co., Trenton, N. J.
Tennessee Coal, Iron & R. R. Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Div. of Colorado Fuel & Iron Corp., Buffalo, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Music
American Brass Co., The, Waterbury, Conn.
American Steel & Wire Co., Cleveland-Chicago, New York
Columbia Steel Co., San Francisco, Calif.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Malin & Co., Cleveland, Ohio.
U. S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

WIRE—Nickel & Nickel Alloy
Eastwood-Nealley Corp., Belleville, N. J.
International Nickel Co., Inc., New York, N.Y.

WIRE—Nickel Silver and Phosphor Bronze
American Brass Co., The, Waterbury, Conn.
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
Malin & Co., Cleveland, Ohio.

WIRE—Non-Ferrous to Specification for Special Purposes
American Brass Co., The, Waterbury, Conn.
Anaconda Wire & Cable Corp., New York, N. Y.
Eastwood-Nealley Corp., Belleville, N. J.
Hudson Wire Co., Ossining, N. Y.
North American Philips Co., Inc., New York, New York.
Reynolds Metals Company, Louisville, Ky.

WIRE—Spring
American Brass Co., The, Waterbury, Conn.
American Steel & Wire Co., Cleveland-Chicago, New York.
Armco Steel Corp., The, Middletown, Ohio.
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Indiana.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Keystone Steel & Wire Co., Peoria, Ill.
Laclede Steel Company, St. Louis, Mo.
Portsmouth Steel Corporation, Portsmouth, Ohio.
U.S. Steel Export Co., New York, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Stainless Steel
American Steel & Wire Co., Cleveland-Chicago, New York
Armco Steel Corp., The, Middletown, Ohio.
Columbia Steel Co., San Francisco, Calif.
Firth Sterling Steel & Carbide Co., McKeesport, Pa.
Tennessee Coal, Iron & Railroad Co., Birmingham, Ala.
U. S. Steel Export Co., New York, N. Y.

WIRE—Steel—Also Coppered Steel—Also Galvanized Steel
Bethlehem Steel Co., Bethlehem, Pa.
Continental Steel Corp., Kokomo, Indiana.
Johnson Steel & Wire Co., Inc., Worcester, Mass.
Kenmore Metals Corp., Jersey City, N. J.
Keystone Steel & Wire Co., Peoria, Ill.
Laclede Steel Company, St. Louis, Mo.
Portsmouth Steel Corporation, Portsmouth, Ohio.
U. S. Steel Export Co., New York, N. Y.
Wickwire Brothers, Inc., Cortland, N. Y.
Youngstown Sheet & Tube Co., Youngstown, O.

WIRE—Straightening and Cutting—
Pittsburgh Cut Wire Co., Pittsburgh, Pa.
Portsmouth Steel Corporation, Portsmouth, Ohio.
Wickwire Brothers, Inc., Cortland, N. Y.

WIRE—Zinc
Platt Bros. & Co., The, Waterbury, Conn.

WIRE CLOTH—Industrial
Roebling's John A., Sons Co., Trenton, N. J.
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire-Spencer Steel Division of Colorado Fuel & Iron Corp., Buffalo, N. Y.

WIRE TESTERS—
Scott Testers, Inc., Providence, R. I.

WIRE. WEAVING—Non-Ferrous
American Brass Co., The, Waterbury, Conn.
Hudson Wire Co., Ossining, N. Y.

WRAPPING PAPER—Creped
Crepe-Kraft Company, The, Division National Waterproof Papers, Inc., Newark, N. J.

YARNS & TAPES—
Belding, Heminway, Corticelli Co., New York, N. Y.
Du Pont de Nemours, E. I., Co., Wilmington, Delaware
Owens Corning Fiberglas Corp., Toledo, Ohio.
Twitchell, E. W., Philadelphia, Pa.

YARN TESTERS—
Scott Testers, Inc., Providence, R. I.

The WATSON MACHINE COMPANY

ESTABLISHED 1845

PATERSON 3, NEW JERSEY, U. S. A.

WATSON

ELECTRICAL WIRE AND CABLE, WIRE ROPE AND CORDAGE MACHINERY

RIGID-FRAME HORIZONTAL STRANDERS TYPE "RH"

These Stranders are the preferred medium for producing Soft Copper and Aluminum Multiple-Layer Concentric Strand of round or sector shape.

PRINCIPAL ADVANTAGES

Strand of a quality equal to that obtainable from planetary equipment is produced in about HALF OF THE TIME while First Cost, Floor Space and Power Requirements are only about TWO THIRDS of planetary types of comparable size and purpose. Equally suitable for all wires of similar ductility such as Aluminum, which can be stranded at still higher speeds. Maintenance is practically NIL.

DESIGN AND CONSTRUCTION

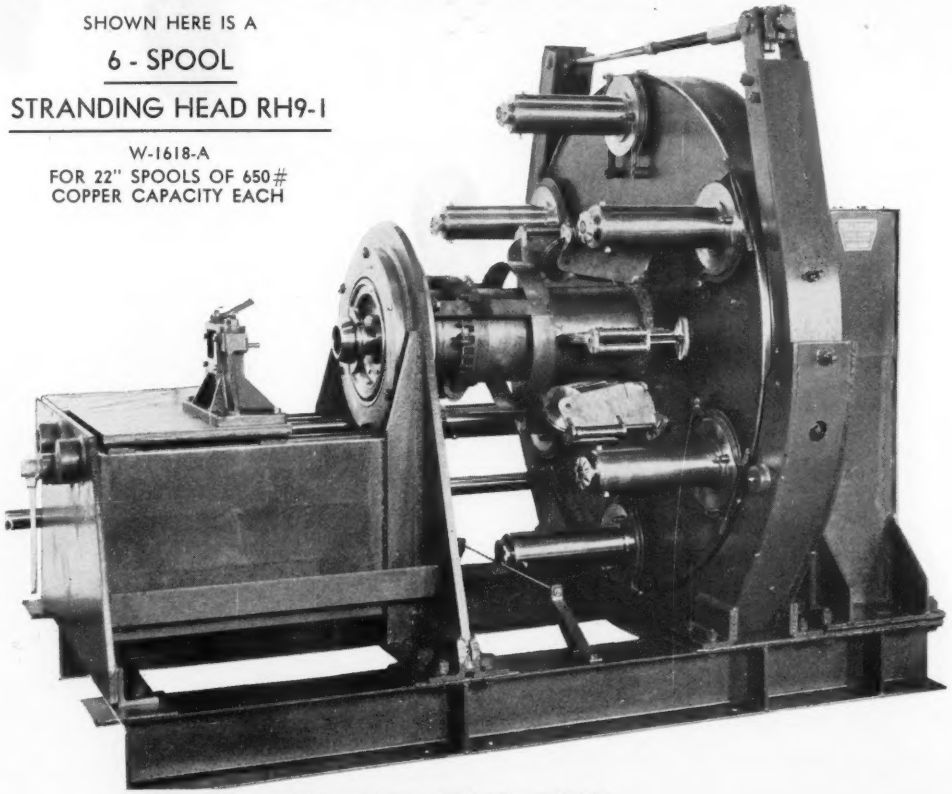
Single Disc design for up to 10" spool heads. Multiple Disc design for up to 22" spool heads. Overhung spool mount allows utmost freedom and rapidity in loading and threading and also full visibility during operation. All Steel and fully "anti-friction" bearing. Fully enclosed and force-feed lubricated drive and change gearing. Large, end-bearing-supported, hollow main shaft. Spool-Twist-Latches with automatic electric latch stop preventing machine operation with latches open. AIR-OFF Brakes. Space for sector-rolling and side tables for transfers. Unbalance allowed for. Lead-thru nests. Adjustable double-shoe spool frictions. Wire Guides guarded against run-off. Pre-spiraling die holders where required.

SHOWN HERE IS A

6 - SPOOL

STRANDING HEAD RH9-1

W-1618-A
FOR 22" SPOOLS OF 650# COPPER CAPACITY EACH

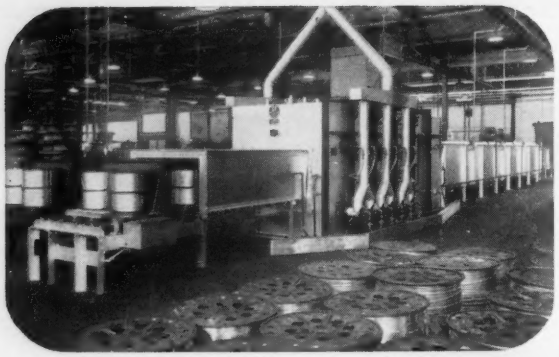


SIZES AND APPLICATIONS

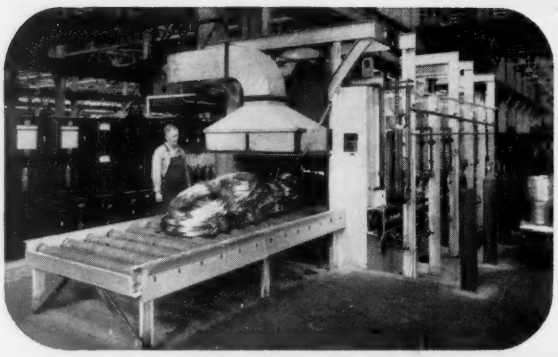
Generally available for 6", 10", 16", 22" and intermediate size dia. spools in Heads grouping 6, 12, 18, 24, 30, 36 and 42 Spools. All sizes are principally designed for concentric-layer stranding but the smaller heads are also much in demand for applying the bare-neutral layer in Service Entrance Cables. Large machines are frequently built in Tandem Arrangement which permits head groups to operate as separate stranders independent from each other, each with its own capstan and takeup, or the entire aggregate may operate as one larger strander whenever required.

* * *

For data and size tabulation request our Machine Bul. 083043

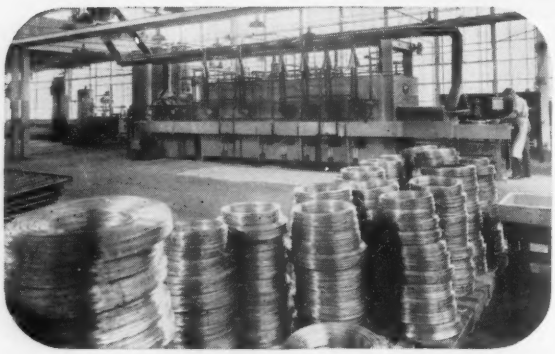


These combination electric and gas fired radiant tube bulkhead tray type furnaces are used extensively for bright annealing wire on reels and in coils.

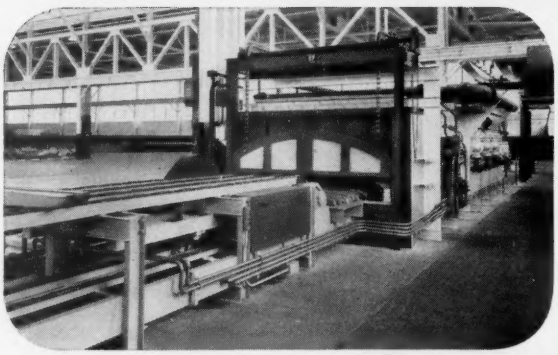


An EF gas-fired three-chamber roller hearth with forced circulating system providing accurate temperature distribution, uniform finish and anneal—continuously.

INVESTIGATE EF DEVELOPMENTS



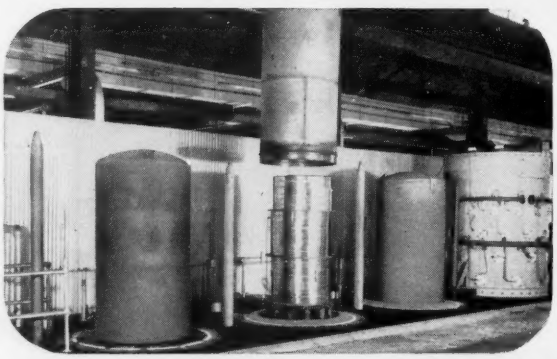
Clean annealing nickel-silver and other alloy wire in an EF gas fired radiant tube continuous roller hearth furnace. Handles coils up to 30" in diameter.



Wire bars up to 66" in length are uniformly and scale-free heated for rolling in this EF gas fired continuous pusher type furnace. Capacity 12,000 lbs. per hour.

FOR EVERY Annealing, Heating or Heat Treating PROCESS

• We have made outstanding production installations for normalizing rod and bright annealing wire in coils, strands, on reels and spools; both ferrous and non-ferrous, including stainless — for heat treating bolts, springs and other wire products — for heating billets, wire bars and other heating and heat treating processes. We solicit your furnace inquiries.



EF gas fired and electric hood, pit and other batch and continuous type furnaces are available for normalizing rod, annealing wire, strip and other processes.

EF

THE ELECTRIC FURNACE CO.

GAS FIRED, OIL FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION

Salem - Ohio